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STATE OF CONNECTICUT.

591 15
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ANNUAL REPORT

OF

The Connecticut Agricultural

EXPERIMENT STATION

For 1888.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN, CONN.
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
1889.

Sci 1625.5

SEP 3 1889

The Station

OFFICERS FOR 1888.

STATE BOARD OF CONTROL.

Ex-officio.

His Exc. PHINEAS C. LOUNSBURY, *President.*

	Term expires
Appointed by Connecticut State Agricultural Society:	
Hon. E. H. HYDE, Stafford, *Vice-President.*	July 1, 1891.
Appointed by Board of Trustees of Wesleyan University:	
Prof. W. O. ATWATER, Middletown.	1888.
Appointed by Governor and Senate:	
EDWIN HOYT, New Canaan.	1889.
H. L. DUDLEY, New London.	1890.

Executive Committee.

Appointed by Board of Agriculture:

T. S. GOLD, West Cornwall. 1889.

Appointed by Governing Board of Sheffield Scientific School:

W. H. BREWER, New Haven, *Secretary and Treas.* 1890.

Ex-officio.

S. W. JOHNSON, New Haven, *Director.*

Chemists.

E. H. JENKINS, Ph.D., *Vice-Director.*
E. H. FARRINGTON, B.S., till July 1.
A. L. WINTON, Jr., Ph.B.
T. B. OSBORNE, Ph.D.
R. S. CURTISS, Ph.B.

Mycologist.

ROLAND THAXTER, Ph.D.

Stenographer and Clerk.

Miss F. M. BIGELOW.

In charge of Buildings and Grounds.

CHARLES J. RICE.

ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established in accordance with an Act of the General Assembly, approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, soils, milk, and other agricultural materials and products, to identify grasses, weeds, and useful or injurious insects, moulds, blights, mildews, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station makes analyses of Fertilizers, Seed-Tests, etc., etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.

2. That the samples are taken from stock now in the market, and in accordance with the Station instructions for sampling.

3. That the samples are fully described and retail prices given on the Station "Forms for Description."

All other work proper to the Experiment Station that can be used for the public benefit will be made without charge. Work done for the use of individuals will be charged for at moderate rates. The Station will undertake no work, the results of which are not at its disposal to use or publish, if deemed advisable for the public good. See p. 22.

Results of analysis or investigation that are of general interest will be published in Bulletins, of which copies are sent to each Post Office in this State, and will be summed up in the Annual Reports made to the Governor.

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of the farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs and like Associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agricul-

ture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties, sent on application.

☞ Parcels by Express, to receive attention, should be *prepaid*, and all communications should be directed, *not to any individual officer*, but simply to the

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

☞ Station Grounds, Laboratories and Office are on Suburban st., between Whitney avenue and Prospect st., 1½ miles North of City Hall. Suburban st. may be reached by the Whitney ave. Horse Cars, which leave the corner of Chapel and Church sts. three times hourly, viz: on the striking of the clock and at intervals of twenty minutes thereafter.

☞ The Station has Telephone connection and may be spoken from the Central Telephone Office, 346 State st., or from Peck and Bishop's Office in Union R. R. Depot.

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STATE OF CONNECTICUT

ANNUAL REPORT

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For 1888.

PART I.

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NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTE
1889.

SEP 8 1890
The Station

REPORT OF THE BOARD OF CONTROL.

To His Excellency, Phineas C. Lounsbury, Governor of Connecticut:

In accordance with the law establishing THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION, the Board of Control herewith submits its Annual Report.

The Congress of the United States in 1887, passed an Act popularly known as the Hatch Bill, appropriating the sum of $15,000 to each of the States and Territories for the support of Experiment Stations. This Act is as follows:

[PUBLIC—NO. 112.]

An act to establish agricultural experiment stations in connection with the colleges established in the several States under the provisions of an act approved July second, eighteen hundred and sixty-two, and of the acts supplementary thereto.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled:

SECTION 1. That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and applications of agricultural science, there shall be established, under direction of the college or colleges or agricultural department of colleges in each State or Territory established, or which may hereafter be established, in accordance with the provisions of an act approved July second, eighteen hundred and sixty-two, entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," or any of the supplements to said act, a department to be known and designated as an "agricultural experiment station:" *Provided*, That in any State or Territory in which two such colleges have been or may be so

established the appropriation hereinafter made to such State or Territory shall be equally divided between such colleges, unless the legislature of such State or Territory shall otherwise direct.

SEC 2. That it shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural or artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other reseaches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States or Territories.

SEC 3. That in order to secure, as far as practicable, uniformity of methods and results in the work of said stations, it shall be the duty of the United States Commissioner of Agriculture to furnish forms, as far as practicable, for the tabulation of results of investigation or experiments; to indicate, from time to time, such lines of inquiry as to him shall seem most important; and, in general, to furnish such advice and assistance as will best promote the purposes of this act. It shall be the duty of each of said stations, annually, on or before the first day of February, to make to the governor of the State or Territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the said Commissioner of Agriculture, and to the Secretary of the Treasury of the United States.

SEC. 4. That bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the States or Territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same, and as far

as the means of the station will permit. Such bulletins or reports and the annual reports of said stations shall be transmitted in the mails of the United States free of charge for postage, under such regulations as the Postmaster-General may from time to time prescribe.

SEC. 5. That for the purpose of paying the necessary expenses of conducting investigations and experiments and printing and distributing the results as hereinbefore prescribed, the sum of fifteen thousand dollars per annum is hereby appropriated to each State, to be specially provided for by Congress in the appropriations from year to year, and to each Territory entitled under the provisions of section eight of this act, out of any money in the Treasury proceeding from the sales of public lands, to be paid in equal quarterly payments, on the first day of January, April, July, and October in each year, to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same, the first payment to be made on the first day of October, eighteen hundred and eighty-seven; *Provided however*, That out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement, or repair of a building or buildings necessary for carrying on the work of such station; and thereafter an amount not exceeding five per centum of such annual appropriation may be so expended.

SEC. 6. That whenever it shall appear to the Secretary of the Treasury from the annual statement of receipts and expenditures of any of said stations that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual appropriation to such station, in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support.

SEC. 7. That nothing in this act shall be construed to impair or modify the legal relation existing between any of the said colleges and the government of the States or Territories in which they are respectively located.

SEC. 8. That in States having colleges entitled under this section to the benefits of this act and having also agricultural experiment stations established by law separate from said colleges, such States shall be authorized to apply such benefits to experiments at stations so established by such States; and in case any

State shall have established under the provisions of said act of July second aforesaid, an agricultural department or experimental station, in connection with any university, college or institution not distinctively an agricultural college or school, and such State shall have established or shall hereafter establish a separate agricultural college or school, which shall have connected therewith an experimental farm or station, the legislature of such State may apply in whole or in part the appropriation by this act made, to such separate agricultural college or school, and no legislature shall by contract express or implied disable itself from so doing.

SEC. 9. That the grants of money authorized by this act are made subject to the legislative assent of the several States and Territories to the purposes of said grants: *Provided*, That payment of such installments of the appropriation herein made as shall become due to any State before the adjournment of the regular session of its legislative meeting next after the passage of this act shall be made upon the assent of the governor thereof duly certified to the Secretary of the Treasury.

SEC. 10. Nothing in this act shall be held or construed as binding the United States to continue any payments from the Treasury to any or all the States or institutions mentioned in this act, but Congress may at any time amend, suspend or repeal any or all the provisions of this act.

Approved, March 2, 1887.

On March 9th, 1887, the Governing Board of the Sheffield Scientific School, the institution which by a Legislative enactment dating back to 1863, was constituted "The College for the benefit of Agriculture and Mechanic Arts," for the State of Connecticut, voted to waive all claims to participation in the avails of the Hatch Bill in favor of The Connecticut Agricultural Experiment Station.

On May 18th, 1887, the General Assembly accepted the offer of Congress and voted to divide the money received equally between The Connecticut Agricultural Experiment Station and a new Experiment Station, which was established in connection with the Storrs Agricultural School at Mansfield. Here follows the act of the General Assembly:

CONCERNING CONGRESSIONAL APPROPRIATIONS TO AGRICULTURAL EXPERIMENT STATIONS.

Resolved by this Assembly: SECTION 1. That this state accepts and assents to the provisions of the act of congress, approved March second, 1887, entitled "An act to establish agricultural experiment stations in connection with the colleges established in the several states, under the provisions of an act approved July second, 1862, and of the acts supplementary thereto."

SEC. 2. The farm attached to the Storrs Agricultural School may be used as an experimental farm for the purposes specified in the act first mentioned; and the trustees of that school and their successors in office are hereby appointed to receive and expend one-half of such moneys as may come to this state, under the provisions of said act first mentioned.

SEC. 3. The board of control of the Connecticut agricultural experiment station and its successors in office is hereby appointed to receive and expend one-half of such moneys as may come to this state under the provisions of said act first mentioned.

Approved, May 18, 1887.

When, after adjournment of Congress in 1887, the "Hatch Bill" was brought to the consideration of the Comptroller of the U. S. Treasury, he decided that the money appropriated had not been "specially provided for by Congress," as required by Sec. 5, and that accordingly further legislation was requisite to enable him to make the intended disbursements.

Early in 1888 Congress passed an act specially providing for the payment of the appropriations for the fiscal year beginning July 1, 1887, and this act was approved by the President on the first day of February. This act also amended Sec. 5 of the Act of 1887 by removing the restriction of payments to money "proceeding from the sales of public lands," and decreeing their payment "out of any money in the Treasury not otherwise appropriated."

The fiscal year of this State, which closed June 30, 1888, was more than two-thirds passed before any portion of the National Appropriation was realized. This unexpected delay, and the uncertainties incident to it made it necessary to modify the work of the station during the early part of 1888. Special meetings of the Board were held in New Haven, Feb. 17th, and April 2d,

to discuss the new conditions brought about by the action of Congress.

It has been a matter of no little solicitude to develop satisfactory plans for the proper expenditure of this addition to the resources of the Station. Various proposals were presented to the Board of Control, and it was decided to establish a new Department for the investigation of the Fungous Diseases of plants, more especially those diseases which affect the crops of this State. The desirability of taking up this line of investigation, with perhaps that of injurious insects, has been frequently discussed by the Board for several years, but the lack of means has heretofore prevented. The National Appropriation now makes it possible, and work has accordingly been undertaken. A new laboratory building for this Department was begun, the walls were up and the building enclosed before the termination of the fiscal year, and it is now nearly complete.

The Station was fortunate in securing the services of Dr. Roland Thaxter, a graduate of Harvard University, and late instructor in Mycology at that institution. Dr. Thaxter began his connection with the Station in July, put himself directly in communication with some of our fruit growers and market gardeners, who are suffering from the ravages of fungi, and is engaged in the needful preliminary work of this department. Books and apparatus, including a Zeiss microscope of approved construction have been provided, and as soon as the heating arrangements, now making, are finished, Dr. Thaxter will begin the culture of various injurious fungi, and make systematic observations and experiments on their growth and habits, and on the methods of controling them.

Dr. Thaxter is now prepared to receive communications on the subject of his department from citizens of the State, who are hereby invited to make inquiries with regard to fungous diseases, including all varieties of rust, smut, mildew, mould, blight, and the like, and to forward to him specimens, concerning which any information may be desired.

At the annual meeting of the Board, in January, the methods of collecting fertilizers were fully discussed. That the farmers and gardeners should know just what commercial fertilizers are offered for sale in the State is evident, and justice to the reputable dealers demands that the collection should be as complete and thorough as possible. The method pursued in 1887 was considered better than any before tried, and it was recommended to

continue the same. It is believed that the collection has been more successfully done this year than ever before.

The Report of the Treasurer is herewith appended. It exhibits the financial affairs of the Station for the fiscal year ending June 30th, and shows the amounts received from the several sources, the amounts spent for various purposes, what part of each has been paid from the National appropriation and what part from Home receipts.

The Report of the Director, which follows, in two parts, describes in classified detail the work of the station for the year ending Dec. 1, 1888.

All of which is respectfully submitted.

WILLIAM H. BREWER,
Secretary.

REPORT OF THE TREASURER.

WM. H. BREWER, *in account with the Connecticut Agricultural Experiment Station.*

FOR THE FISCAL YEAR ENDING JUNE 30, 1888.

RECEIPTS.

Balance from old account	$ 3.39	
From State Comptroller	8,000.00	
" U. S. Treasurer	7,500.00	
Analysis Fees	3,081.50	
Various other receipts	21.26	
		$18,606.15

EXPENDITURES.

	State Ac't.	U. S. Ac't.	Total.
Salaries	$6,081.83	$3,427.50	$9,509.33
General Laboratory Expenses	783.02	858.37	1,641.39
The Establishment, Grounds, Buildings, Repairs, etc.	470.72	.....	470.72
Gas	74.12	141.78	215.90
Water	66.00	66.00	132.00
Coal	650.75	.....	650.75
Telephone	100.15	.....	100.15
Printing	370.67	.....	370.67
Stationery	116.54	65.00	181.54
Postage	156.39	.....	156.39
Library	248.37	.....	248.37
Mycological Library	.....	639.48	639.48
Mycological Laboratory	.....	348.13	348.13
Grass and Forage Investigation	304.64	.....	304.64
Field Experiments	52.41	454.20	506.61
Collecting Fertilizers	575.69	.....	575.69
Traveling Expenses of the Board	57.16	.....	57.16
New Building	568.46	1,499.54	2,068.00
Miscellaneous Sundries	422.99	.....	422.99
	$11,099.91	$7,500.00	$18,599.91
Balance to new account			6.24
			$18,606.15

MEMORANDUM.—*The year's accounts were audited Sept. 13, 1888, by the Auditors of the State Public Accounts. Certain analysis fees due the Station at the close of the previous fiscal year ending June 30th, 1887, known at the time or discovered later, have since been collected and the sums are placed in this year's receipts.*

The analysis fees of some of the fertilizers known or believed to have been on sale (in the State) since May 1st, are not yet received by the Treasurer, and others will probably be reported. As heretofore, any collections that may come from such sources will go into the new account.

WM. H. BREWER, Treasurer.

REPORT OF THE DIRECTOR.

Under the requirements of the fertilizer law, as well as in answer to the requests of purchasers of commercial fertilizers, a large share of the time and labor of the working force of this Station has been employed during the year in the collection and analysis of fertilizers and fertilizing materials.

The whole number of brands of commercial fertilizers legally sold in Connecticut during the year has been 140. The law requires this Station to make and publish annually, at least one analysis of each of these. Examination of home-mixed fertilizers and waste products has brought the whole number of fertilizer-analyses up to 244. Each analysis has been made in duplicate and in almost all cases the duplicates have been executed by different chemists.

During April and May, special agents of the Station, Messrs. E. C. Ellwood, of Green's Farms, and C. L. Gold, of West Cornwall, visited 144 cities, towns and villages in the State and drew 887 samples of fertilizers, reporting also all cases where the requirements of the fertilizer law appeared not to be fully met.

About 130 samples of feeding-stuffs have been or are now being analyzed, and the results of all accessible American analyses of this kind which have been published during the year have also been tabulated and averaged.

Fourteen samples of potatoes have been analyzed in connection with field experiments.

At request of the State Cattle Commission a portion of the stomach of a cow was minutely examined, for both organic and inorganic poisons, with negative results. This examination was made for the Station by Professor Herbert E. Smith, of New Haven.

All the chemical work required by the Dairy Commissioner during the year has been done at this Station, including examinations of 11 samples of suspected butter and 50 samples of molasses.

About 30 partial analyses of milk have been made, chiefly in testing methods of milk-analysis.

The work done and observations made in connection with the Forage Garden are described on subsequent pages (Part 2).

About 150 specimens of grasses and sedges have been sent in from all parts of the State, to be named and for information regarding their value, etc.

Ten field experiments have been carried out, to test the relative value of various phosphates applied as a fertilizer to Indian corn and potatoes, with the coöperation of the following gentlemen:

Robert Aitken	Shaker Station.
C. S. Andrews, Jr.	New Britain.
W. I. Bartholomew	Putnam.
W. R. Fish	Mystic Bridge.
Edwin Hoyt	New Canaan.
G. F. Platt	Milford.
E. A. Russell	Suffield.
C. A. Sill	Saybrook.
W. H. Yeomans	Columbia.

A single experiment on the growth of sorghum was conducted by J. H. Dickerman, Esq., of Mt. Carmel.

An elaborate investigation on the effect of distance of planting on the quality and quantity of the maize crop has been made with the coöperation of J. J. Webb, Esq., of Hamden.

The chemical and field work pertaining to these experiments is described in detail in Part 2.

The Station has published and distributed in editions of 5000 copies, two printed Bulletins aggregating 25 pages. The object of these Bulletins is to place in the hands of those concerned the results of the Station work as promptly as possible.

As required by law, a package of each Bulletin is mailed to every post-office in the State. The package is directed to the postmaster, with a request to distribute to farmers. The number sent will be increased, in any case, on application. The distribution of these Bulletins is of course optional with the postmaster.

The Bulletins are also regularly sent to every Newspaper in the State, and to the Secretary of each Agricultural Society, Farmers' Club and Grange whose address is known to the Station.

The Bulletins are sent, also, to any citizen of Connecticut who applies for them. Such application, as a rule, must be renewed annually early in the year.

The Publications of the Station will be furnished freely to applicants not citizens of Connecticut, so far as the limited editions will permit.

In lieu of other Bulletins, it has been decided to issue in December a complete account of the fertilizer analyses made during the fiscal year, as Part 1 of the Annual Report. Part 2 of the Report will go to press at a little later date, because its printing will necessarily be delayed till the results of the farm experiments can be obtained and tabulated.

The Station has also issued five Weekly Statements printed in a very limited edition by the hektograph process and supplied as far as possible to the agricultural press, and to Secretaries of farmers' clubs and agricultural societies.

The necessary Station correspondence increases from year to year and during the last eleven months has involved the sending of some 1800 manuscript letters and reports of analyses.

During the year the Station has been visited by a larger number of Connecticut farmers and citizens than ever before. On Oct. 10 a field meeting of the Board of Agriculture was held at the Station at which about one hundred people were present.

Early in July, Mr. E. H. Farrington, who had served the Station most acceptably for 5½ years, left to accept a position in the New Hampshire Experiment Station. Mr. R. S. Curtiss, Ph.B. (Yale Univ.), joined the Station as chemist in August. During the summer, Dr. D. N. Harper, now chemist to the Minnesota Experiment Station, Prof. H. B. Patton, of Rutgers College, N. J., and Mr. W. M. Saunders, of Rhode Island, spent some time in our laboratory, to familiarize themselves with our methods of work.

The steam-heating arrangement in use at the Station having proved inadequate during extreme cold weather, and being of a kind not adapted for maintaining uniform temperature in the Laboratories, a new heating apparatus has been put in which it is anticipated will not only prove much more powerful, but also much more convenient and economical than that hitherto employed.

For use in the Chemical Laboratory, a very effective mill to pulverize fodders for analysis, of the kind recommended by Prof. Märcker, of the Saxon Experiment Station at Halle, has been procured through the kind offices of Dr. A. T. Neale, of the New Jersey Station. The address of the manufacturer of this mill is

Grusonwerk, Magdeburg-Buckau, Prussia. To operate this mill an Otto gas-engine has been set up, which also takes the place of hand labor in pulverizing samples of fertilizers and performing various other work.

The Chemical Laboratory is in pressing need of enlargement and improvement. The small fund available for its construction six years ago, necessitated building it in the simplest manner and on a too restricted scale of dimensions. It was foreseen that it must soon become inadequate and was planned with a view to extension. The table-room has been too small already for several years, so that much time is lost in putting together and taking down combinations of apparatus that are almost constantly required for various processes of analysis and which could be placed permanently in position for use if the space were available for that purpose. A large table with sink is needed for the exclusive use of the Laboratory Assistant in cleaning apparatus. Cases for containing and classifying Laboratory supplies, which now must be hunted for in the sampling rooms, the attic, or the cellar, and two rooms—one for storing costly instruments that are but occasionally used, and another as a shop and repair room, are urgently demanded. Some improvements in our present laboratory are also requisite. A small steam boiler, to supply distilled water and heat for evaporations and drying baths, would advantageously and economically replace our present arrangements, which were make-shifts at the outset, are on too small a scale, inconvenient, and from long wear must soon be replaced by something new. The mortar of the ventilating flues is so corroded by acid fumes that sand is constantly falling and endangering our analyses. These flues should be lined with glazed tiles or pipes, both to save the work of the chemists and to protect the chimneys themselves from ruin. I recommend that the Legislature be asked to appropriate $10,000 to increase the capacity of the Laboratory and to make the needed changes. Such enlargement and improvement would enable our chemists to accomplish a much greater amount of work and be a great gain to all concerned.

THE CONNECTICUT FERTILIZER LAW.

The General Assembly at its session in 1882 passed a Fertilizer Law which went into effect September 1, 1882, and which repealed and took the place of all previous legislation on this subject. The law is still in force without any amendment. Since a full understanding of the provisions and penalties of this law is important to all who buy or sell commercial fertilizers the law is here reprinted and attention is specially directed to the following points :

1. In case of fertilizers that retail at ten dollars or more per ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER shall have provided labels or statements and shall have paid the fee. Sections 1 and 3.

2. The law also requires, in case of any fertilizer selling at ten dollars or more per ton, that a *certified statement* of composition. net weight in package, etc., shall be filed with the Director of the Experiment Station, and that a *sealed sample* shall be deposited with him by the MANUFACTURER OR IMPORTER. Section 2.

3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price* shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4.

4. All "CHEMICALS" that are applied to land, such as : Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Lime (Gypsum or Land Plaster), Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 9 of the Act.

Here follows the full text of the law, with explanatory footnotes.

AN ACT CONCERNING COMMERCIAL FERTILIZERS.

GENERAL ASSEMBLY,
January Session, A. D. 1882.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. Every person or company who shall sell, offer, or expose for sale, in this State, any commercial fertilizer or manure, the retail price of which is ten dollars, or more than ten dollars per ton, shall affix conspicuously to every package thereof a plainly printed statement, clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand, or trade-mark under which the fertilizer is sold, the name and address of the manufacturer, the place of manufacture and the chemical composition of the fertilizer, expressed in the terms and manner approved and currently employed by the Connecticut Agricultural Experiment Station.*

Printed statement to be affixed to all packages and to go with all lots.

If any such fertilizer be sold in bulk, such printed statement shall accompany and go with every lot and parcel sold, offered, or exposed for sale.

SEC. 2. Before any commercial fertilizer, the retail price of which is ten dollars, or more than ten dollars per ton, is sold, offered, or exposed for sale, the manufacturer, importer, or party who causes it to be sold, or offered for sale, within the State of Connecticut, shall file with the Director of the Connecticut Agricultural Experiment Station two certified copies of the statement named in section one of this act, and shall deposit with said

Before sale *certified copies* of statement, and *Sealed Sample* to be deposited with Director.

* A statement of the per cents. of Nitrogen, Phosphoric Acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the per cent. of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The per cent. of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of soluble and reverted.

Insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the chemical composition may take account of the two ingredients: Nitrogen, Phosphoric Acid.

For Potash Salts give always the per cent. of Potash (potassium oxide); that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

director a sealed glass jar or bottle containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.*

SEC. 3. The manufacturer, importer, agent, or seller of any commercial fertilizer, the retail price of which is ten dollars or more than ten dollars per ton, shall pay on or before the first of May, annually, to the Director of the Connecticut Agricultural Experiment Station, an analysis fee of ten dollars for each of the fertilizing ingredients† contained or claimed to exist in said fertilizer: *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any persons acting as agents or sellers for such manufacturer or importer, such agents or sellers shall not be required to pay the fee named in this section.

Analysis Fee to be paid annually on or before May 1st.

SEC. 4. Every person in this State who sells, or acts as local agent for the sale of any commercial fertilizer of whatever kind or price, shall annually, or at the time of becoming such seller or agent, report to the Director of the Connecticut Agricultural Experiment Station his name, residence, and post-office address, and the name and brand of said fertilizer, with the name and address of the manufacturer, importer, or party from whom such fertilizer was obtained, and shall, on demand of the Director of the Connecticut Agricultural Experiment Station, deliver to said director a sample suitable for analysis of any such fertilizer or manure then and there sold or offered for sale by said seller or agent.‡

Yearly Report to Station of Dealers: or Agents.

SEC. 5. No person or party shall sell, offer, or expose for sale, in the State of Connecticut, any pulverized leather, raw, steamed, roasted, or in any form, as a fertilizer or as an ingredient of any fertilizer or manure, without explicit printed certificate of the fact, such certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany and go with every parcel or lot of the same.

Leather.

* The analysis of samples sent in accordance with section two is discretionary with the Station. Such samples are intended for preservation as manufacturers' standards.

† The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, viz: Nitrogen, Phosphoric acid and Potash. The analysis-fees in case of any fertilizer will therefore be ten, twenty or thirty dollars, according as one, two or three of these ingredients are contained or claimed to exist in the fertilizer.

On receipt of statements, samples and analysis-fees, the Station will issue Certificates of Compliance with the law.

‡ Blanks for Dealers' Reports will be mailed to applicants.

Fish-guano, &c

SEC. 6. Every manufacturer of fish guano, or fertilizers of which the principal ingredient is fish or fish-mass from which the oil has been extracted, shall, before manufacturing or heating the same, and within thirty-six hours from the time such fish or mass has been delivered to him, treat the same with sulphuric acid or other chemical, approved by the director of said experiment station, in such quantity as to arrest decomposition: *provided, however*, that in lieu of such treatment such manufacturers may provide a means for consuming all smoke and vapors arising from such fertilizers during the process of manufacture.

Fines.

SEC. 7. Any person violating any provision of the foregoing sections of this act shall be fined one hundred dollars for the first offense, and two hundred dollars for each subsequent violation.

Fertilizers for private use.

SEC. 8. This act shall not affect parties manufacturing, importing, or purchasing fertilizers for their own private use, and not to sell in this State.

Director's duties and authority.

SEC. 9. The director of the Connecticut Agricultural Experiment Station shall pay the analysis-fees received by him into the treasury of the station, and shall cause one or more analysis of each fertilizer to be made and published annually. Said director is hereby authorized, in person or by deputy, to take samples for analysis from any lot or package of manure or fertilizer which may be in the possession of any dealer.

Bulletins.

SEC. 10. The director of the Connecticut Agricultural Station shall, from time to time, as bulletins of said station may be issued, mail or cause to be mailed two copies, at least, of such bulletins to each post-office in the State.

Repeal of former acts.

SEC. 11. Title sixteen, chapter fifteen, sections fifteen and sixteen, and title twenty, chapter twelve, section five of the general statutes, and chapter one hundred and twenty of the public acts of 1881, being an act concerning commercial fertilizers, are hereby repealed.

SEC. 12. This act shall take effect on the first day of September, 1882.

It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in section 9, that all fertilizers be analyzed and it requires the parties making or selling them to pay for these analyses in part; the State itself paying in part by maintaining the Experiment Station.

OBSERVANCE OF THE FERTILIZER LAW.

MANUFACTURERS who have paid Analysis Fees as required by the Fertilizer Law, and Fertilizers for which the fees have been thus paid for the year ending May, 1889.

Firm.	*Brand of Fertilizer.*
Adams, Wm. P., 248 Front St., N. Y.	High Grade Ammoniated Bone Superphosphate. Lion Brand Fish and Potash. Pure Raw Bone.
Apothecaries Hall Co., Waterbury, Conn.	Victor Phosphate.
H. J. Baker & Bro., 215 Pearl St., N. Y.	A. A. Ammoniated Superphosphate. Potato Fertilizer. Corn Fertilizer. Strictly Pure Ground Bone. Castor Pomace.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Stockbridge Grain Manure. " Forage Crop Manure. " Vegetable Manure. Bowker's Hill and Drill Phosphate. " Ammoniated Dissolved Bone. " Fish and Potash. " Pure Dry Fish.
Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Bradley's Complete Manure for Potatoes and Vegetables. Bradley's Complete Manure for Corn and Grain. Bradley's Complete Manure for Top Dressing Grass and Grain. Bradley's Superphosphate. B. D. Sea Fowl Guano. Original Coe's Superphosphate. Circle Brand Ground Bone and Potash. Bradley's Potato Manure. Farmer's New Method Fertilizer. Pure Fine Ground Bone. Fish and Potash, Anchor Brand. " " " Triangle A Brand.
Clark's Cove Guano Co., New Bedford, Mass.	Bay State Fertilizer. Unicorn Ammoniated Superphosphate. King Philip Alkaline Guano. Great Planet A Fertilizer. " " B "
Coe, E. Frank, 16 Burling Slip, N. Y.	Potato Fertilizer. Excelsior Red Brand Fertilizer. Alkaline Bone. High Grade Ammoniated Bone Superphosphate. Ground Bone. Fish and Potash.

Firm.	*Brand of Fertilizer.*
Coe, Russell, Tremley, N. J.	Ammoniated Superphosphate.
Cooper's, Peter, Glue Factory, 17 Burling Slip, N. Y.	Peter Cooper's Bone Dust.
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Ammoniated Bone Superphosphate. Potato, Hop and Tobacco Phosphate. Queen City Phosphate. Pure Ground Bone. Superphosphate No. 2.
Cumberland Bone Co., Portland, Me.	Cumberland Superphosphate. Seeding Down Fertilizer.
L. B. Darling Fertilizer Co., Pawtucket, R. I.	Darling's Animal Fertilizer. " Extra Bone Phosphate. " Pure Fine Bone.
Davidge Fertilizer Co., 121 Front St., N. Y.	Davidge's Potato Manure. " Special Favorite.
Dawley, T. R., Griswold, Conn.	Baugh's Twenty five Dollar Phosphate.
Dickenson, D. B., Middle Haddam, Conn.	Ammoniated Bone Phosphate.
Downs & Griffin, Derby, Conn.	Ground Bone.
Great Eastern Fertilizer Co., Rutland, Vt.	Great Eastern General Fertilizer. Vegetable, Vine and Tobacco Fertilizer.
Kelsey, E. R., Branford, Conn.	Fish and Potash.
Lister's Agricultural Chemical Works, Newark, N. J.	Lister's Standard Phosphate. Ammoniated Dissolved Bone. Special Potato Manure. Special Corn Manure. Ground Bone.
Luce Brothers, Niantic, Conn.	Dry Ground Fish Guano.
Mapes' Formula and Peruvian Guano Co., 158 Front St., N. Y.	Potato Manure. Corn Manure. Complete Manure for light soils. " " "A" Brand. " " for general use. Fine Bone Dissolved. Tobacco Manure, Conn. Brand. " " Wrapper Brand. Fruit and Vine Manure. Peruvian Guano. Grass and Grain Spring Top Dressing.
C. Meyer, Jr., Maspeth, Long Island.	Acme Fertilizer No. 1. " " No. 2. " Potato Fertilizer.
Miles, G. W., Agent for John Guyer, Milford, Conn.	Fish and Potash, Fish Brand. I. X. L. Ammoniated Bone Superphosphate.
Miller, G. W., Middlefield, Conn.	Flour of Bone Phosphate. Pure Ground Bone.

Firm.	*Brand of Fertilizer.*
Miller, H. S., & Co., Newark, N. J.	Standard Phosphate. Ammoniated Dissolved Bone. Pure Bone Meal.
Mitchell, A., Tremley, N. J.	Standard Superphosphate.
National Fertilizer Co., Bridgeport, Ct.	Chittenden's Complete Fertilizer. " Ammon'd Bone Phosphate " Fish and Potash. " Ground Bone.
Newton & Ludlam, 182 Front St., N. Y.	Cereal Fertilizer. Cecrops Fertilizer.
Orient Guano M'f'g Co., 16 and 18 Exchange Place, N. Y.	Fish and Potash. Orient Complete Manure.
Peck Bros., Northfield, Conn.	Pure Ground Bone.
Prentice, Charles, Putnam, Conn.	Phosphate. Ground Bone.
Preston Fertilizer Co., Greenpoint, L. I.	Ammoniated Bone Superphosphate. Potato Fertilizer. Ground Bone.
Quinnipiac Co., New London, Conn.	Quinnipiac Phosphate. Pine Island Phosphate. Potato Manure. Fish and Potash No. 1. " " " No. 2. Pequot Fish and Potash. Dry Ground Fish. Ground Bone. Muriate of Potash.
Rogers & Hubbard Co., Middletown, Conn.	Raw Knuckle Bone Flour. Strictly Pure Fine Bone. Pure Ground AX Bone. Fairchild's Formula for Corn. " " Bone and Potash. Rogers & Hubbard Co's Complete Potato and Tobacco Manure.
Sanderson, L., 119 Long Wharf, New Haven, Conn.	Sanderson's Mixed Formula. Blood, Bone and Meat. Fine Ground Bone. Dissolved Bone Black. Sulphate of Potash. Muriate of Potash. Sulphate of Ammonia. Nitrate of Soda.
Shoemaker, M. L., & Co., Philadelphia, Pa., by F. Ellsworth, Hartford, Conn.	Swift Sure Superphosphate. " " Bone Meal.
Soluble Pacific Guano Co., Glidden & Curtis, agents, Boston, Mass.	Soluble Pacific Guano. Fish and Potash.
Spencer, Chas. L., Suffield, Conn.	Cotton Hull Ashes.

Firm.	*Brand of Fertilizer.*
Sperry & Barnes, New Haven, Conn.	Dried Blood and Meat.
Standard Fertilizer Co., 118½ Milk St., Boston, Mass.	Standard Superphosphate.
St. Louis Lead & Oil Co., St. Louis, Mo., by Olds & Whipple, Hartford, Conn.	St. Louis Lead & Oil Co's Castor Pomace.
Thompson & Edwards Fertilizer Co., Union Stock Yards, Chicago, Ill.	Pure Fine Ground Bone.
Wilkinson & Co., 52 and 54 William St., N. Y.	Economical Bone Fertilizer.
Williams & Clark Co., Cotton Exchange Building, Hanover Square, N. Y.	Americus Pure Bone Meal. Royal Bone Phosphate. Americus Brand Tobacco and Onion Fertilizer. Americus Brand Potato Fertilizer. Americus Ammoniated Bone Superphosphate. Williams & Clark Co's Potato Phosphate

ANALYSES OF FERTILIZERS.*

In respect to its terms, the Station makes *two classes* of analyses of fertilizers and fertilizing materials: the first for the benefit of farmers, gardeners, and the public generally; the second for the private use of manufacturers and dealers. Analyses of the *first class* are made gratuitously, and the results are published as speedily and widely as possible for the guidance of purchasers and consumers. Those of the *second class* are charged for at moderate rates, and their results are not published in a way to interfere with their legitimate private use. The Station however, distinctly reserves the liberty to use at discretion, for the public benefit, all results obtained in its laboratory, and in no case will enter into any privacy that will work against the public good.

During 1888, 244 samples of fertilizers have been analyzed. Of these, a small number were examined for private parties and for testing methods in connection with other Experiment Stations, and the remainder for the general use of the citizens of the State.

During April and May last Messrs. E. C. Ellwood, of Green's Farms, and C. L. Gold, of West Cornwall, agents of this Station, have collected samples of Commercial Fertilizers in all parts of Connecticut. 144 towns and villages have been visited, distributed as follows:

Hartford Co.	18
Tolland Co.	11
Windham Co.	14
New London Co.	26
Middlesex Co.	20
New Haven Co.	22
Fairfield Co.	20
Litchfield Co.	13
	144

887 samples were taken by these gentlemen, who employed the method of sampling which is described on page 91 of the Report of this Station for 1884.

* The matter of this and several subsequent pages, explanatory of the sampling and valuation of fertilizers, is copied, with a few appropriate alterations, from the Report for 1887. This repetition appears to be necessary for the use of readers who have not seen former Reports.

In this way one or more samples were secured of nearly every brand of fertilizer which is offered for sale within the State. When several samples of a single brand were drawn in different parts of the State the analysis was performed, not on any single sample, but on a mixture made of an equal weight of each of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of single samples.

The Station agents are instructed when drawing samples, in every case to open at least three packages of each brand, and if the number of packages is large, to take a portion from every tenth one, by means of a sampling tube, which withdraws a section or core through the entire length of the bag or barrel.

The greatest care is necessary in sampling fertilizers so that the small sample taken shall accurately represent the whole stock from which it is drawn.

As a rule the Station will not analyze samples—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

The Station desires the coöperation of farmers, farmers' clubs and granges in calling attention to new brands of fertilizers and in securing samples of all goods offered for sale. All samples drawn by other than Station agents are understood to be taken in accordance with the printed instructions which the Station supplies to all applicants. Here follows a copy of these instructions.

Gratuitous Analysis of Commercial Fertilizers.

To insure justice to manufacturers, dealers and consumers alike, the Station will make gratuitous analyses of Commercial Fertilizers *only* on samples taken by the Agents of the Station, or on such other samples as are *fully* described on the Station Forms for Description and taken in accordance with the Station Instructions for sampling, and furthermore are properly authenticated by the certificate of the person drawing the sample, *and in addition* the witness, either

1. Of a Selectman;
2. Of an Officer of a farmer's club, grange or local agricultural society; or

3. Of the Dealer from whose stock the sample is taken.

In case a Dealer takes samples of his own stock, the witness of one of the Officers aforesaid will be required.

In special cases of importance the Station may send its Agent to draw samples.

Instructions for Sampling Commercial Fertilizers.

1. Provide a teacup, some large papers, and for each sample a glass fruit-can or tin box holding about one quart that can be tightly closed, all to be clean and dry.

2. Open at least three full and unbroken packages, or if there are more than thirty, every tenth package, and mix well together the contents of each for a foot in depth; take out two cupfuls from different parts of the mixed portions of each package, pour them [six in all] one over another upon a paper, intermix thoroughly but quickly to avoid gain or loss of moisture, fill the can or box from this mixture, close tightly, fix securely on the outside of the can a label with some distinguishing letter or mark (which is to be copied in the "Description of Sample" as *sampler's mark*), and send prepaid to the Agricultural Experiment Station, New Haven, Conn.

3. If convenient weigh separately at least three packages and enter these *actual weights* in the "Description of Sample."

4. When a sample has been taken it should *always* be bottled, labeled and the form for its description filled out completely *before* beginning to sample another fertilizer.

Further Remarks on Sampling.

In case of a fine, uniform and moist or coherent article, a butter tryer or a tin tube, like a dipper handle, put well down into the packages in several places, will give a fair sample with great ease.

With dry, coarse articles, such as ground bone, there is liable to be a separation of coarse and fine parts on handling. Moist articles put up in bags or common barrels may become dry on the outside. It is in these cases absolutely necessary to mix thoroughly the coarse and fine, the dry and the moist portions, before sampling.

The quantity sent should not be too small. When the material is fine and uniform, a pint is enough, but otherwise and especially in the case of ground bone, which must be mechanically analyzed, the sample should not be *less than one quart.*

It is important that samples for analysis should be taken at the time when the fertilizer is purchased, and *immediately dispatched* to the Station. Moist fish, blood or cotton seed meal will soon decompose and lose ammonia, if bottled and kept in a warm place. Superphosphates containing much organic nitrogen will suffer reversion of their soluble phosphoric acid under similar circumstances. Most of the moist fertilizers will lose water unless tightly bottled, but some of the grades of potash salts will gather moisture from the air and become a slumpy mass if not thoroughly protected.

Samples as to whose authenticity or fairly representative character there is any reasonable doubt, the Station will not analyze. The Station reserves the right to reject samples taken from less than half a ton of stock or those drawn from goods that have been wintered over from last year.

Send with each sample any printed circular, pamphlet, analysis or statement that accompanies the fertilizer or is used in its sale.

Description of Sample.

Station No..... Rec'd at Station,..... ..., 188

Each sample of Commercial Fertilizer sent for gratuitous analysis *must* be accompanied by a Description made by filling out legibly and as fully as possible, the blanks that follow:

Sampler's Mark.....
Brand of Fertilizer.....
Name and address of Manufacturer.....
.....
Name and address of Dealer from whom this sample was taken,
.....
Date of taking this sample.....
Is it stated to be fresh stock?.....
Dealer's cash price per ton or hundred, bag or barrel.....
Selling weight claimed for each package weighed.....
Actual weights of the several packages opened.....
Number of packages from which the sample was taken.....

Here write the per cents of valuable ingredients which the fertilizer is guaranteed to contain.

Soluble Phosphoric Acid.....Nitrogen.....
Reverted Phosphoric Acid.....(Ammonia.....)
(Available Phosphoric Acid.....) Potash.....
Insoluble Phosphoric Acid.....

Certificate of Person taking the Sample.

I, the undersigned, certify that the accompanying sample marked.....was taken by me from full packages, and in accordance with the Station's Instructions for Sampling and to the best of my knowledge and belief fairly represents the stock from which it was drawn, and that said stock when sampled was properly housed and in good condition. I also certify that the foregoing description is correct.

Signature.....
Post Office address.....

Witness of Officer or Dealer.

The above described sample was drawn in my presence.

Signature.....
Title.....
Township.....
Post Office Address.....

On receipt of any sample of fertilizer from the open market, the filled out "Form for Description" which accompanies it is filed in the Station's Record of Analyses, and remains there as a voucher for the authenticity of the sample and for the fact that it has been taken fairly, or, at least, under suitable instructions. It is thus sought to insure that manufacturers and dealers shall not suffer from the publication of analyses made on material that does not correctly represent what they have put upon the market.

The "Form for Description," when properly filled out, also, contains all the data of cost, weight, etc., of a fertilizer which are necessary for making, with help of the analysis, a valuation of its fertilizing elements, and estimating the fairness of its selling price. Neglect to give full particulars occasions the Station much trouble, and it is evident that want of accuracy in writing up the description may work injustice to the manufacturers or dealers, as well as mislead consumers. It is especially important that the *brand* of a fertilizer and its *selling price* shall be correctly given. The price should be that actually charged by the dealer of whom it is bought, and if the article be purchased in New York or other distant market, that fact should be stated, and the cost at the nearest point to the consumer, on rail or boat, should be reported also.

In all cases, when possible, *ton prices* should be given, and if the sale of an article is only by smaller quantities, that fact should be distinctly mentioned.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a copy of it is sent to the party who furnished the sample and also to the manufacturer, in order that there may be opportunity for explanation or protest, if desirable, before the results are published in the Bulletin.

With the analysis there is sent to the party furnishing the sample a printed page of "Explanations," intended to embody the principles and data upon which the valuation of fertilizers is based.

These Explanations are essential to a correct understanding of the analyses that are given on subsequent pages, and are, therefore, reproduced here, as follows:

Explanations Concerning the Analysis of Fertilizers and the Valuation of their Active Ingredients.

Revised.

Nitrogen is the most rare, and commercially, the most valuable fertilizing element.

Free Nitrogen is indeed universally abundant in the common air, but in this form its effects in nourishing vegetation are as yet obscure, or even doubtful.

Organic Nitrogen is the nitrogen of animal and vegetable matters, where it is chemically united to carbon, hydrogen and oxygen. Some forms of organic nitrogen, as those of blood, flesh and seeds, are highly active as fertilizers; others, as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated.

Ammonia (NH_3) *and nitric acid* (N_2O_5) are results of the decay of *organic nitrogen* in the soil and manure heap, and contain Nitrogen in its most active forms. They occur in commerce —the former in sulphate of ammonia, the latter in nitrate of soda. 17 parts of ammonia or 66 parts of pure sulphate of ammonia contain 14 parts of nitrogen. 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

Phosphorus is, next to nitrogen, the least abundant and most costly ingredient of Fertilizers, in which it always exists in the form of phosphates, usually those of calcium, iron, and aluminum, or in case of "superphosphates" in the form of phosphoric acid.

Soluble Phosphoric acid implies phosphoric acid or phosphates that are freely soluble in water. It is the characteristic ingredient of Superphosphates, in which it is produced, by acting on "insoluble" or "reverted" phosphates, with diluted sulphuric acid (oil of vitriol). Once well incorporated with the soil it gradually becomes reverted phosphoric acid.

Reverted (reduced or precipitated) Phosphoric acid means strictly, phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid. In present usage the term signifies the phosphoric acid (of various phosphates) that is freely taken up by a strong solution of ammonium citrate, which is therefore used in analysis to determine its quantity. "Reverted phosphoric acid" implies phosphates that are readily assimilated by crops.

Recent investigation tends to show that soluble and reverted phosphoric acid are on the whole about equally valuable as plant-food and of nearly equal commercial value. In some cases, indeed, the soluble gives better results on crops, in others the reverted is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric acid implies various phosphates not soluble in water or ammonium citrate. In some cases the phosphoric acid is too insoluble to be readily available as plant food. This is especially true of the crystallized green Canada Apatite. Bone-black, bone-ash, South Carolina Rock and Navassa Phosphate when in coarse powder are commonly of little repute as fertilizers though good results are occasionally reported from their use. When *very finely pulverized* ("floats") they more often act well, especially in connection with abundance of decaying vegetable matters. The phosphate of calcium in raw bones is nearly insoluble, because of the animal matter of the bones, which envelopes it; but when the latter decays in the soil, the phosphate remains in essentially the "reverted" form. The phosphoric acid of "Thomas-Slag" and of "Grand Cayman's Phosphate" is freely taken up by crops.

Phosphoric acid in all the Station Analyses is reckoned as "Anhydrous phosphoric acid" (P_2O_5) also termed among chemists, phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

Potassium is the constituent of Fertilizers, which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the shape of muriate (potassium chloride).

The Valuation of a Fertilizer, as practised at this Station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw materials of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to

their chemical composition, but guanos, superphosphates and similar articles, for which $30 to $60 per ton are paid, depend chiefly for their trade-value on the three substances, *nitrogen, phosphoric acid* and *potash*, which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above-named Ingredients*, a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

The average Trade-values or retail cost in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash, as found in the New England, New York and New Jersey markets, are as follows:—

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS FOR 1888.

	Cts. per lb.
Nitrogen in ammonia salts	17½
nitrates	16
Organic nitrogen in dry and fine ground fish, meat, blood, cotton-seed meal and castor pomace	16½
in fine bone and tankage	16½
in fine medium bone and tankage	13
in medium bone and tankage	10½
in coarse bone and tankage	8½
in hair, horn shavings and coarse fish scrap	8
Phosphoric acid, soluble in water	8
soluble in ammonium citrate*	7½
in dry ground fish, fine bone and tankage	7
in fine-medium bone and tankage	6
in medium bone and tankage	5
in coarse bone and tankage	4
in fine ground rock phosphate	2
Potash as high-grade Sulphate and in forms free from Muriate (or Chlorides)	5½
as kainit	4½
as muriate	4½

* Dissolved from 2 grams of the unground phosphate previously extracted with pure water, by 100 c. c. neutral solution of Ammonium Citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

These Trade-values were agreed upon by the Experiment stations of New Jersey, Massachusetts and Connecticut, for use in their respective States during 1888. They are the average prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those raw materials which are the regular source of supply. They also correspond to the average wholesale prices for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices* at the large markets of standard raw materials, such as:

Sulphate of Ammonia,
Nitrate of Soda,
Dried Blood,
Azotin,
Ammonite,
Dry Ground Fish,
Bone and Tankage,
Ground So. Carolina Rock.
Plain Superphosphate,
Muriate of Potash,
Sulphate of Potash.

Trade Values in Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The organic nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality.

Insoluble Phosphoric Acid is reckoned at 3 cents, unless found to be from rock phosphate. In this latter form Insoluble Phosphoric Acid costs but 2 cents per pound. Potash is rated at 4½ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of Potash is reckoned at 5½ cents.

In most cases the valuation of the Ingredients in Superphosphates and Specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles. These charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investment, bad debts, and finally, profits.

The majority of manufacturers agree that the average cost of mixing, bagging, handling and cartage ranges from $3.00 to $4.50 per ton.

In 1888 the average selling price of Ammoniated Superphosphates and Guanos was $34.55, the average valuation was $28.70, and the difference, $5.85—an advance of 20.3 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

In case of Special Manures the average cost was $39.47, the average valuation $33.99, and the difference $5.48, or 16.1 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of Nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

In case of *Ground Bone*, the sample is sifted into four grades and we separately compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton, by the per cent. of each grade, taking $\frac{1}{100}$th of that product, multiplying it by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade, thus obtained, together with the values of each grade for phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

The uses of the "Valuation" are twofold:

1, To show whether a given lot or brand of fertilizer is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price; but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

2, Comparisons of the valuations and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for analysis cannot always decide accurately what is the *form* of nitrogen, etc., while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second-named use of valuation frequent changes of the trade-values are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth, when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of a year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

The Agricultural value of a fertilizer is measured by the benefit received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that Peruvian guano, superphosphates, fish-scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

CLASSIFICATION OF FERTILIZERS ANALYZED.

The fertilizers and manurial waste products analyzed at the Station laboratory from November 1st, 1887, to November 1st, 1888, were as follows:

RAW MATERIALS COMMONLY USED IN MIXED FERTILIZERS.

1. *Containing Nitrogen as the Chief Valuable Ingredient.*

Nitrate of Soda	3
Sulphate of Ammonia	4
Cotton Seed Meal	9
Castor Pomace	2

2. *Containing Phosphoric Acid.*

Thomas Slag	1
Native Phosphates	6
Dissolved Bone Black	4

3. *Containing Potash.*

Sulphate of Potash	4
Muriate of Potash	8
Kainit	1

4. *Containing Nitrogen and Potash.*

Bone Manures	36
Bone and Potash	1
Tankage	7
Dry Ground Fish	2

MIXED FERTILIZERS.

Nitrogenous Superphosphates and Guanos	93
Special Manures	33
Home-Mixed Fertilizers	12

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes	7
Hardwood, Unleached Canada Ashes	2
Hardwood Ashes from a Brick Kiln	1
Tobacco Stems and Tobacco Dust	3
Hen Manure	1
Slaughter-house Refuse	1
Plaster	3
Total	244

These analyses are discussed in the order above given on subsequent pages.

I. RAW MATERIALS OF HIGH-GRADE CONTAINING NITROGEN AS THE CHIEF VALUABLE INGREDIENT.

NITRATE OF SODA.

Nitrate of Soda is mined in Chili and purified there before shipment. It usually contains about 16 per cent. of nitrogen, equivalent to 97 per cent. of pure nitrate of soda. It contains besides, a little salt and some moisture. The usual guarantee is "96 per cent." of nitrate of soda equivalent to 15.8 per cent. of nitrogen.

2190. Sold by the Rogers & Hubbard Co., Middletown, guarantee 98.75 pure nitrate of soda.

2176. Sold by L. Sanderson, New Haven, guarantee 19–20 ammonia.

ANALYSES.

	2190	2176
Moisture	.35	.85
Salt (sodium chloride)	.23	.33
Sulphate of soda	.21	.16
Pure nitrate of soda	99.21	98.66
	100.00	100.00
Contains nitrogen	16.37	16.28
Cost per ton	$52.00	50.00
Nitrogen costs per pound	**15.9 cts.**	**15.4 cts.**

SULPHATE OF AMMONIA.

This article, now manufactured on a large scale as a by-product of gas-works, usually contains over 20 per cent. of nitrogen, the equivalent of from 94 to 97 per cent. of sulphate of ammonia. The rest is chiefly moisture. The usual guarantee is 25 per cent. of ammonia which is equivalent to 20.6 per cent. of nitrogen, but commercial sulphate of ammonia commonly contains less than that quantity.

2170. Sold by L. Sanderson, New Haven. Sampled and sent by J. J. Webb, Hamden.

2213. Made by C. Meyer, Jr., Maspeth. From stock bought by G. F. Platt, Milford, for home mixtures.

2217. Made by C. Meyer, Jr. From stock bought and sampled by C. T. Merwin & Son, Milford.

2230. Made by C. Meyer, Jr. From stock bought and sampled by Dennis Fenn, Milford.

ANALYSES.

	2170	2213	2217	2230
Nitrogen	20.02	20.15	20.12	20.02
Equivalent ammonia	24.30	24.46	24.42	24.30
Cost per ton	$70.00	71.60*	71.60*	71.60*
Nitrogen costs per pound,	**17.5 cts.**	**17.8 cts.**	**17.9 cts.**	**17.7 cts.**

* Ton lots in Milford.

Cotton Seed Meal.

The seed of the cotton plant, after ginning to remove the cotton fibre, passes through a mill which hulls or decorticates it. The hulled seed is ground and the oil is expressed by hydraulic pressure. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer.

2172. Sold by F. S. Harmon, Suffield. Sampled and sent by H. K. Wright, Suffield.

2173. Sold by W. W. Cooper, Suffield. Sampled and sent by H. K. Wright, Suffield.

2201. Sold by J. E. Soper & Co., Boston. Sampled and sent by C. W. Austin, Suffield, from stock bought by him.

2202. Light colored, from stock of R. H. Ensign, Simsbury. Sampled and sent by J. C. Eddy, Simsbury.

2203. Dark colored, from stock of J. & H. Woodford, Avon. Sampled and sent by J. C. Eddy, Simsbury.

2235. Sold by Olds & Whipple, Hartford.

2244. Sold by F. S. Harmon, Suffield.

2253. Dark colored. Sold by J. E. Soper & Co., Boston. Sampled and sent by H. S. Frye, Poquonock.

Analyses.

	2172	2173	2201	2202	2203	2235	2244	2253
Nitrogen	7.38	7.13	6.95	7.65	6.97	7.23	7.42	7.20
Phosphoric acid	3.06	3.40	3.11	2.81	3.60	2.85	3.69	....
Potash	1.91	1.91	1.96	1.81	2.09	1.73	2.08	....
Cost per ton	$25.00	26.00	25.00	25.00	25.00	25.00	25.00	
Nitrogen costs per pound, in cents*	**12.6**	**13.4**	**13.3**	**12.5**	**12.7**	**13.2**	**11.9**	

* Reckoning phosphoric acid at 7 cents and potash at 5½ cents per pound.

The analyses show that this material has been the cheapest source of available nitrogen during the last season.

Castor Pomace.

This is the ground residue or cake of castor beans from which castor oil has been extracted by pressure.

2236. Made by the St. Louis Lead and Oil Co. Sold by Olds & Whipple, Hartford.

2247. Made by H. J. Baker & Bro., 215 Pearl St., N. Y.

ANALYSES.

	2236	2247
Nitrogen	5.78	5.76
Phosphoric acid	1.87	1.71
Potash	1.22	.91
Cost per ton	$20.00	20.00
Nitrogen costs per pound*	**13.9 cts.**	**14.4 cts.**

* Reckoning the phosphoric acid at 7 cents per pound and the potash at 5½ cents.

Castor pomace, like cotton seed meal, has been one of the cheapest sources of available nitrogen this season.

II. Raw Materials of High Grade Containing Phosphoric Acid.

Thomas Slag and Native Phosphates.

The following were used in the field experiments carried out in various parts of the state for this Station and which are described in the latter part of the present report.

2194. Thomas Slag or Thomas Phosphate Meal, a by-product of the manufacture of steel from ores containing phosphorus. Bought of Paul Weidinger, 76 Pine St., New York City.

2193. Ground South Carolina Rock. Purchased for the Station by the Mapes Formula and Peruvian Guano Co., New York City.

2195. Grand Cayman's Phosphate. A phosphatic deposit from Grand Cayman's Island. Bought of N. P. Powter, New York City.

2397. Bolivian Guano. A phosphatic guano from the West Indies, sold by the Quinnipiac Fertilizer Co., and bought from their agent, R. B. Bradley & Co., New Haven.

ANALYSES.

	2194	2193	2195	2397
Phosphoric acid	19.62	25.53	26.22	17.15
Cost per ton	$15.00	14.50	15.00	15.00
Phosphoric acid, costs per pound	**3.8 cts.**	**2.8 cts.**	**2.9 cts.**	**4.3 cts.**

Dissolved Bone Black.

This material is a superphosphate prepared by treating refuse bone black from sugar refineries with oil of vitriol which renders nearly all of the phosphoric acid soluble in water.

Phosphoric acid in dissolved bone black is considerably more expensive than in dissolved South Carolina rock, but the latter material does not get into the retail market in this state for some reason, perhaps for a lack of a demand for it. Phosphoric acid in dissolved rock was bought in New Jersey for about 6 cents a pound the last year, and granges or farmers' clubs that buy in considerable quantity would do well to inquire for it.

2182. Sold by L. Sanderson, New Haven, guaranteed 16–18 per cent. available.

2214. Sold by C. Meyer, Jr., Maspeth, L. I., guaranteed 16–18 per cent. available. From stock bought by G. F. Platt, Milford.

2223. Sold by C. Meyer, Jr. Sampled and sent by C. T. Merwin & Son, Milford.

2228. Sold by C. Meyer, Jr. Sampled and sent by Dennis Fenn, Milford.

Analyses.

	2182	2214	2223	2228
Soluble phosphoric acid	15.68	14.55	14.38	15.78
Reverted phosphoric acid	.85	2.39	3.66	1.35
Insoluble phosphoric acid	none	.20	.60	.37
Cost	$26.00	27.60*	27.60*	27.60*
Soluble phosphoric acid costs per pound†	**7.9 cts.**	**8.2 cts.**	**8 cts.**	**8.1 cts.**

* Ton lots in Milford.

† Reckoning the reverted acid at 7½ cents and insoluble at 2 cents per pound.

III. Raw Materials of High Grade Containing Potash.

Sulphate of Potash.

The double sulphate of potash and magnesia is usually sold as "sulphate of potash" on a guarantee of "48–50 per cent. sulphate" which is equivalent to 25.9–27 per cent. of actual potash. It contains, besides some 46–50 per cent. of sulphate of potash, over 30 per cent. of sulphate of magnesia, chlorine equivalent to 3 per cent. of common salt, besides sulphates of soda and lime, with varying quantities of moisture.

Attention is called to the high grade sulphate containing about 94–95 per cent. of pure sulphate of potash. The cost of actual potash is somewhat higher in this than in the double sulphate of potash and magnesia.

2178. Double sulphate of potash and magnesia. Stock of L. Sanderson, New Haven.

2209. High grade sulphate of potash, guarantee 95 per cent. sulphate. Sold by C. Meyer, Jr., Maspeth, L. I. From stock bought by G. F. Platt, Milford.

2225. High grade sulphate of potash. Sold by C. Meyer, Jr. Sampled and sent by Dennis Fenn, Milford.

ANALYSES.

	2178	2209	2225
Actual potash	27.76	51.28	50.68
Equivalent sulphate of potash	51.3	94.8	93.7
Cost per ton	$30.00	61.60*	61.60*
Potash costs per pound	5.4 cts.	6 cts.	6.1 cts.

* Ton lots in Milford.

MURIATE OF POTASH.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride), 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water. It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of actual potash.

2168. From stock bought of L. Sanderson, New Haven. Sampled and sent by J. J. Webb, Hamden.

2177. Stock of L. Sanderson, guarantee, 80–85 per cent. muriate.

2188. Stock of the Rogers & Hubbard Co., Middletown, guarantee, 80 per cent. muriate.

2212. From stock bought of C. Meyer, Jr., Maspeth, L. I., by G. F. Platt, Milford. Guarantee 82 per cent. muriate.

2221. From stock bought of C. Meyer, Jr. Sampled and sent by C. T. Merwin & Son, Milford.

2226. From stock bought of C. Meyer, Jr. Sampled and sent by Dennis Fenn, Milford.

ANALYSES.

	2168	2177	2188	2212	2221	2226
Actual potash.....	50.0	51.17	50.88	52.52	53.30	52.82
Equivalent muriate.	79.2	81.0	80.6	83.2	84.4	83.7
Cost per ton	$41.50	41.50	43.00	41.60*	41.60*	41.60*
Cost of potash per pound, in cents	**4.2**	**4.1**	**4.2**	**4.0**	**3.9**	**3.9**

* Ton lots in Milford.

IV. RAW MATERIALS CONTAINING NITROGEN AND PHOSPHORIC ACID.

BONE MANURES.

The terms "Bone Dust," "Ground Bone," "Bone Meal" and "Bone" applied to fertilizers, may in some cases, signify material, made from dry, clean and pure bones such as shank bones used in making knife handles; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon and grease—and if taken from garbage or ash heaps, with ashes or soil adhering; again they denote mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam-tanks in order to recover grease, and are then dried and sold as "tankage;" or, finally, they apply to bone from which a large share of the nitrogenous substance has been in extracted in the glue manufacture. The nitrogen of all these varieties of bone when they are in the same state of mechanical subdivision has essentially the same fertilizing value.

Since it now rarely happens that ground bone or tankage is to any considerable extent coarser than $\frac{1}{8}$ inch, the valuation this year is made on four grades only, viz:

Fine, smaller than $\frac{1}{20}$ inch.
Fine-medium, between $\frac{1}{20}$ and $\frac{1}{10}$ inch.
Medium, between $\frac{1}{10}$ and $\frac{1}{5}$ inch.
Coarse, larger than $\frac{1}{5}$ inch.

1. *Sampled by Station Agents.*

On pages 40 to 43 will be found the tabulated analyses of 25 different brands of this class.

Bone Manures.—Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost Per Ton.
2240	Peter Cooper's Pure Bone Dust.	Peter Cooper's Glue Factory, 17 Burling Slip, N. Y.	Chas. Jennings, Southport.	$26.00
2365	Peter Cooper's Pure Bone Dust.	Peter Cooper's Glue Factory, 17 Burling Slip, N. Y.	Apothecaries Hall Co., Waterbury.	32.00
			Wilson & Burr, Middletown.	28.00
			Geo. Beaumont, Wallingford.	27.00
2362	Baker's Strictly Pure Bone.	H. J. Baker & Bro., 215 Pearl St., New York City.	C. O. Jelliff & Co., Southport.	30.00
			Harry Sedgwick, Cornwall Hollow.	32.00
				30.00
			Allen Betts, Norwalk.	35.00
2373	Quinnipiac Bone Meal.	Quinnipiac Co., New London, Ct.	Chandler & Morse, Putnam.	33.00
			E. A. Godfrey, Bridgeport.	36.00
			E. J. Dickerman, Mt. Carmel.	32.00
			Martin Bros., Wallingford.	32.00
			J. E. Hall, Colchester.	33.00
			A. P. Smith, Lebanon.	34.00
			Bought by Comstock, Ferre & Co., for their own use.	36.00
			J. M. Belden, New Britain.	28.00
2191	Pure Ground AX Bone.	Rogers & Hubbard Co., Middletown, Conn.	Manufacturer.	
2211	Ground Bone.	C. Meyer, Jr., Maspeth, L. I.	Geo. F. Platt, Milford.	
2371	Ground Bone.	Chas. Prentice, Putnam, Conn.	Manufacturer.	31.00
2181	Ground Bone.	Unknown.	L. Sanderson, 119 Long Wharf, New Haven.	35.00

Bone Manures.—Sampled by the Station,—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost Per Ton.
2367	Darling's Fine Ground Bone.	L. B. Darling Fertz. Co., Pawtucket, R. I.	Dunham & Co., West Cheshire.	$32.00
			W. S. Vinton, Coventry.	35.00
			T. Pease & Sons Co., Windsor Locks.	35.00
			Quinnebaug Store, Danielsonville.	35.00
			J. P. Barstow & Co., Norwich.	35.00
			H. K. Brainard, Thompsonville.	40.00
			J. M. Belden, New Britain.	35.00
2185	Raw Knuckle Bone Flour.	Rogers & Hubbard Co., Middletown, Ct.	Manufacturer.	36.00
2192	Strictly Pure Fine Bone.	Rogers & Hubbard Co., Middletown, Ct.	Manufacturer.	32.00
2363	Bradley's Pure Fine Ground Bone.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Cochrane Bros., West Cornwall.	35.00
			Raymond Bros., South Norwalk.	35.00
			David Beers, Danbury.	36.00
			Waterbury & June, Greenwich.	35.00
			T. Pease & Sons Co., Windsor Locks.	35.00
			W. F. Andross, East Hartford.	35.00
			M. H. Tanner, Winsted.	36.00
			C. S. Gillette, Cheshire.	34.00
			J. A. Lewis, Williamantic.	33.00
			A. J. Ives, Meriden.	35.00
			Oscar Leach, Durham.	36.00
			E. C. Dennis, Stafford Springs.	33.00
			Strong & Backus, Colchester.	32.00
			G. A. Dickerman, Haddam.	36.00
			Loomis Bros., Granby.	35.00
			E. E. Spicer, Groton.	35.00
2208	Bradley's Pure Fine Ground Bone.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	From stock bought by Greens Farm Farmers' Club.	34.–35.

Bone Manures.—Sampled by the Station,—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost Per Ton.
2179	Ground Bone.	Unknown.	L. Sanderson, Long Wharf, New Haven.	$35.00
2372	Preston's Pure Ground Bone.	Preston Fertilizer Co., Greenpoint, L. I.	J. B. Merrow & Son, Merrow.	30.00
2369	H. S. Miller & Co's Ground Bone.	H. S. Miller & Co., Newark, N. J.	Staples & Raymond, Westport.	25.00
			Southington Lumber and Feed Co., Southington, Conn.	27.00
2180	Ground Bone.	Unknown.	L. Sanderson, Long Wharf, New Haven.	35.00
2375	Americus Pure Bone Meal.	Williams & Clark Co., Hanover Square, N. Y.	C. S. Gillette, Cheshire.	34.00
			J. O. Fox & Co., Putnam.	35.00
			J. A. Paine, Danielsonville.	
			L. F. Ellis, Woodmont.	33.00
			W. E. Payne, Rockville.	35.00
			John Bransfield, Portland.	40.00
2234	Swift Sure Bone Meal.	M. L. Shoemaker & Co., Phila., Pa.	F. Ellsworth, Hartford.	40.00
2366	Crocker's Pure Ground Bone.	Crocker Fertilizer Co., Buffalo, N. Y.	Chandler & Morse, Putnam.	37.00
			J. L. Bragg, Canaan.	38.00
2395	Chittenden's Ground Bone.	National Fertilizer Co., Bridgeport, Ct.	F. P. Burr & Co., Middletown.	34.00
			W. B. Martin, Rockville.	34.00
2364	E. F. Coe's Ground Bone.	E. Frank Coe, 16 Burling Slip, N. Y.	I. W. Denison, Mystic River.	33.00
			Simon Banks, Southport.	28.00
			H. W. Elliott, North Haven.	35.00
2361	Adams' Pure Raw Bone.	W. P. Adams, 248 Front St, N. Y.	W. S. Ellis, Gilead.	38.00
			F. H. Tillinghast, Central Village.	39.00
2370	Peck Bros. Ground Bone.	Peck Bros., Northfield, Conn.	Augustus Meeker, Westport.	33.00
2238	Lister's Ground Bone.	Lister Agricultural Chemical Works, Newark, N. J.	A. N. Clark, Milford.	28.00
2368	Lister's Ground Bone.	Lister Agricultural Chemical Works, Newark, N. J.	G. W. Dennison, Saybrook.	29.00

Analyses of Bone Manures.—Sampled by the Station.

Station No.	Name or Brand.	Chemical Analysis.		Mechanical Analysis.					Cost per ton.	Valuation per ton.	Percentage difference between cost and valuation.
				Finer than				Coarser than			
		Nitrogen.	Phos. Acid.	1/60 inch.	1/30 inch.	1/12 inch.	1/6 inch.	1/6 inch.			Valuation exceeds cost.
2240	Peter Cooper's Pure Bone Dust	1.68	29.96	36	13	26	25	..	$26.00	$37.75	31.1
2365	Peter Cooper's Pure Bone Dust	1.47	31.37	47	17	24	12	..	29.00	41.55	30.2
2362	Baker's Strictly Pure Bone	3.85	23.70	79	21	..	..	..	32.00	44.32	27.8
2373	Quinnipiac Bone Meal	2.87	25.50	75	16	9	..	..	33.00	42.80	22.9
2191	Rogers & Hubbard Co.'s Pure Ground AX Bone	3.52	22.39	42	25	23	10	..	28.00	36.28	22.8
2211	C. Meyer, Jr.'s Ground Bone	3.87	21.16	52	36	12	..	..	29.60*	38.31	22.7
2371	Chas. Prentice's Ground Bone	3.88	23.51	47	26	24	3	..	31.00	39.80	22.1
2181	Sanderson's Ground Bone	2.59	27.19	74	23	3	..	..	35.00	44.51	21.3
2367	Darling's Fine Ground Bone	2.65	26.10	76	18	6	..	..	35.00	43.19	19.0
2185	Rogers & Hubbard Co.'s Raw Knuckle Bone Flour	3.74	24.96	66	27	7	..	..	36.00	44.22	18.6
2192	Rogers & Hubbard Co.'s Strictly Pure Fine Bone	4.00	22.74	42	28	30	..	..	32.00	38.81	17.6
2363	Bradley's Pure Fine Ground Bone	3.88	21.58	63	29	8	..	..	34.00	39.91	15.0
2208	Bradley's Pure Fine Ground Bone	3.91	20.61	74	26	..	..	..	34.00	39.97	14.9
2179	Sanderson's Ground Bone	3.98	22.32	56	41	3	..	..	35.00	41.00	14.6
2372	Preston Fertilizer Co.'s Pure Ground Bone	3.58	21.33	8	8	15	22	47	30.00	26.42	13.6
2369	H. S. Miller & Co.'s Ground Bone	2.22	18.48	57	23	18	2	..	26.00	29.89	13.0
2180	Sanderson's Ground Bone	4.18	21.26	52	33	15	..	..	35.00	39.14	10.5
2375	Americus Pure Bone Meal	2.94	23.86	62	18	15	5	..	35.00	38.96	10.1
2234	Swift Sure Bone Meal	6.23	20.23	58	26	15	1	..	40.00	44.12	9.3
2366	Crocker's Pure Ground Bone	4.14	23.71	44	24	30	2	..	37.50	40.27	6.8
2395	Chittenden's Ground Bone	2.71	22.89	53	21	16	10	..	34.00	35.76	5.0
2364	E. Frank Coe's Pure Ground Bone†	2.42	21.46	49	22	14	8	7	33.00	33.69	2.5
2361	Adams' Pure Raw Bone	3.82	21.16	59	35	6	..	..	38.50	39.02	1.3
											Cost exceeds valuation.
2370	Peck Bro's Pure Ground Bone	4.19	21.07	8	16	33	40	3	30.00	29.43	1.9
2238	Lister's Ground Bone	3.44	14.28	22	17	29	30	2	28.00	23.15	20.9
2368	Lister's Ground Bone	3.34	15.01	18	21	38	21	2	29.00	23.81	21.8

* In Milford.

† Also contains 1.29 per cent. of potash.

Bone Manures.—Manufacturers' Samples and Samples Sent by Purchasers.

Station No.	Name or Brand.	Manufacturer.	Sample drawn by	Cost per ton.
2169	Sanderson's Fine Bone.	.....	J. J. Webb, New Haven.	$35.00
2222	Pure Ground Bone.	C. Meyer, Jr., Maspeth, L. I.	C. T. Merwin & Son, Milford.	29.60*
2227	Ground Bone.	C. Meyer, Jr., Maspeth, L. I.	Dennis Fenn, Milford.	29.60*
2171	Pure Bone Meal.	H. S. Miller & Co., Newark, N. J.	Charles H. Jones, Westport.	33.00
2166	Pure Fine Ground Bone.	Bradley Fertilizer Co., Boston, Mass.	George Ellwood, Southport.	35.00
2300	Ground Bone.	Downs & Griffin, Birmingham, Ct.	Manufacturers.	30.00
2374	Pure Fine Ground Bone.	Thompson & Edwards Fertilizer Co., Chicago, Ill.	Manufacturers.	----
2378	Pure Ground Bone.	Peck Bros., Northfield, Ct.	Manufacturers.	30.00
2382	Animal Dust.	L. B. Darling Fertilizer Co., Pawtucket. R. I.	J. B. Smith, New Britain.	28.00
2387	Ground Bone.	H. C. Hall.	J. O. Ives, Meriden.	30.00

* Ton lots in Milford.

Analyses of Bone Manures.—Sampled by Manufacturers and Purchasers.

Station No.	Name or Brand.	Chemical Analysis.		Mechanical Analysis.					Cost per ton.	Valuation per ton.	Percentage difference between cost and valuation.
				Finer than				Coarser than			
		Nitrogen.	Phos. Acid.	1/60 inch.	1/30 inch.	1/15 inch.	1/8 inch.	1/8 inch.			
											Valuation exceeds cost
2169	Sanderson's Ground Bone	2.70	27.07	75	21	4	--	--	$35.00	$44.71	21.7
2222	C. Meyer's Pure Ground Bone	4.03	21.57	34	49	17	--	--	29.60	37.69	21.4
2227	C. Meyer's Ground Bone	3.88	20.33	52	34	14	--	--	29.60	37.71	20.3
2171	H. S. Miller & Co's Pure Bone Meal	3.57	23.43	48	24	28	--	--	33.00	39.03	15.4
2166	Bradley's Pure Fine Ground Bone	4.02	21.11	67	33	--	--	--	35.00	40.48	13.5
2300	Downs & Griffin's Ground Bone	4.44	23.24	14	11	35	40	--	30.00	32.77	8.4
2374	Thompson & Edward's Pure Fine Ground Bone	3.86	22.29	59	23	18	--	--	----	39.86	----
											Costexceeds Valuation.
2378	Peck Bros. Pure Ground Bone	4.11	20.86	10	16	35	37	2	30.00	29.54	1.5
2382	Darling's Animal Dust	5.65	10.61	34	18	22	16	10	28.00	25.97	7.8
2387	Hall's Ground Bone	3.93	21.79	--	--	1.5	4.0	94 5	30.00	25.34	18.3

Leaving out of account Lister's and E. F. Coe's bone which are mixtures of bone with potash or soda salts, the average cost of 22 samples is $32.80 and the valuation $39.07. The trade-values used by the Station for the valuation of bone are accordingly still too high and should be further reduced to make them coincide with the market quotations.

2. *Manufacturers' Samples.*

On pages 44 and 45 will be found analyses of three samples of bone furnished by manufacturers in accordance with the terms of the fertilizer law.

3. *Samples Sent by Purchasers.*

Six analyses of this kind are included in the table on pages 44 and 45.

Bone and Potash.

An analysis of Bradley's Circle Brand Bone and Potash is tabulated with the nitrogenous superphosphates because, having been treated with acid, it is properly a superphosphate.

2189. Fairchild's Formula Bone and Potash. Made by the Rogers & Hubbard Co., Middletown. Sampled from manufacturer's stock by Station Agent.

Mechanical Analysis.*

Fine, smaller than $\frac{1}{10}$ inch	37 per cent.
Fine medium, smaller than $\frac{1}{8}$ inch	18 "
Medium, smaller than $\frac{1}{4}$ inch	29 "
Coarse, larger than $\frac{1}{4}$ inch	16 "
	100 "

Chemical Analysis and Valuation.

Nitrogen	2.90
Phosphoric acid	17.74
Potash (as muriate)	14.72
Cost per ton	$40.00
Valuation per ton	$40.41

* Made after removing salts soluble in water.

Tankage.

This material consists of various kinds of offal but chiefly of cooked bone and meat which collects on the bottom of the tanks in which grease is separated from the waste of slaughter-houses

and meat markets. It is very variable in composition, some samples being chiefly meat, others largely bone.

2175. Western Tankage. Stock of L. Sanderson, New Haven. Guarantee 6–8 ammonia, 10–12 phosphoric acid.

2183. New York Tankage. Stock of L. Sanderson. Guarantee 6–8 ammonia, 10–12 phosphoric acid.

2210. New York Tankage. Sold by C. Meyer, Jr., Maspeth. From stock bought by G. F. Platt, Milford. Guarantee 9 ammonia, 5 phosphoric acid.

2220. New York Tankage. Sold by C. Meyer, Jr. Sampled and sent by C. T. Merwin, Milford.

2229. New York Tankage. Sold by C. Meyer, Jr. Sampled and sent by Dennis Fenn, Milford.

2243. Tankage. Made by Sperry & Barnes, New Haven. Manufacturers' sample.

MECHANICAL ANALYSES.

	2175	2183	2210	2220	2229	2243
Fine, smaller than $\frac{1}{50}$ inch	64	58	21	14	22	68
Fine medium, smaller than $\frac{1}{25}$ inch	21	25	19	14	21	13
Medium, smaller than $\frac{1}{12}$ inch	14	17	17	12	21	10
Coarse, larger than $\frac{1}{12}$ inch	1	--	43	60	36	9
	100	100	100	100	100	100

CHEMICAL ANALYSES.

	2175	2183	2210	2220	2229	2243
Nitrogen	7.02	5.81	8.37	8.84	8.76	7.85
Phosphoric acid	13.49	17.46	3.98	4.01	3.56	5.60
Cost per ton	$35.00	35.00	29.60*	29.60*	29.60*	
Valuation per ton	$38.32	39.34	22.50	21.16	24.13	30.60

* Ton lots in Milford.

DRY GROUND FISH.

In the two brands here specified the manufacturers' guarantees and the Station analyses refer alone to nitrogen. These articles are accordingly not included among the ammoniated superphosphates given on subsequent pages.

2267. Sold by Luce Brothers, Niantic. Manufacturers' sample.

2336. Made by Bowker Fertilizer Co., Boston. Sample from W. F. Andross, East Hartford.

	2267	2336
Nitrogen	8.20	8.46
Equivalent ammonia	9.96	10.27

Mixed Fertilizers.

I. Nitrogenous Superphosphates and Guanos.

Here are included mixed fertilizers containing nitrogen, phosphoric acid and in most cases potash, which are not designed by their manufacturers for use on any special crops. "Special Manures" are noticed further on. Fish scrap is classified with these goods because it is sometimes acidulated with oil of vitriol to preserve it, thus making it a nitrogenous superphosphate.

1. *Samples drawn by Station Agent.*

In the tables on pages 50 to 62 are given sixty-nine analyses of this kind.

After the name of a brand of goods the names of a number of dealers are frequently given. This indicates that a sample of the goods was drawn by our agent from each dealer named and that the corresponding analysis was made on a mixture of equal parts of all these samples.

The Station assumes full responsibility for accuracy of sampling and analysis only on such samples as are drawn by its own agents. On samples drawn by other persons the Station holds itself responsible only for the accuracy of analysis, but requires before making an analysis a formal statement that the person who drew the sample did it in accordance with the Station directions. See page 25.

Early in the year a circular was sent to all manufacturers whose goods were sold in Connecticut, asking them to inform the Station what would be about the average cash price of their goods in this State during the coming season. In the tables with the various *dealers'* quotations is also given for comparison the *manufacturers'* statement of the average retail cash price per ton in the State in cases where the manufacturer supplied such statement. The cash prices are usually about five per cent. lower than the credit or "time" prices.

The retail cash price of the same fertilizer as quoted by different dealers varies in some cases considerably, partly on account of differences in freight-rates, presence or absence of competition, etc. Some manufacturers arrange with their selling agents so that a given brand shall be sold at a uniform price at all points in the State, but usually the price charged is fixed by the dealer.

The last column of the table of analysis is "Percentage Difference between Cost and Valuation." Its significance and the method of calculating it may be seen by noticing the eighth analysis in the table on page 59, No. **2338**. Here the cost is $32, the valuation is $30.03, and the difference between them is $1.97. By multiplying this difference, $1.97, by 100, and dividing it by the valuation, $30.03, we get 6.6, the percentage advance of selling price over valuation, which advance should represent the costs and profits of the manufacturer in converting the raw materials into a mixed fertilizer, selling it and collecting on his sales.

DIFFERENCE BETWEEN COST AND VALUATION.

Leaving out of account the last analysis in the tables in which the cost exceeded valuation by more than 50 per cent. the average cost of 68 nitrogenous Superphosphates was $34.55, and the average valuation $28.70. The difference is $5.85, and the percentage difference 20.3.

That is, the same quantities of nitrogen, phosphoric acid and potash, which were contained in an average ton of Nitrogenous Superphosphate could have been bought in raw materials of standard quality in ton lots in this State for $28.70 cash, in the average Superphosphate they cost $34.55, and hence the manufacturers' and dealers' expenses and profits on a ton of fertilizer averaged $5.85, or 20.3 per cent. of the cost of the materials.

Guarantees.—The analyses of 21 superphosphates out of the 69 show that their composition is below the minimum guarantee in one or more particulars. Fourteen are deficient in one ingredient, six in ten and one in the three ingredients. In most cases the deficiency is due to a misleading, and in this State illegal, method of expressing the guarantee of potash. It is required, under the law, that the quantity of *actual* potash shall be expressly stated. "Potash, Sulphate, 4 per cent." means four per cent. of *actual potash* in the form of sulphate, and not 2.16 per cent. of potash.

Fish and Potash.—The analyses of this material which has been a favorite fertilizer in this State, though tabulated with the nitrogenous superphosphates are also tabulated by themselves on page 63. Most of the brands are not simple mixtures of fish scrap and potash salts, as the name would imply, but contain other phosphates and in one case much *insoluble* phosphate.

Nitrogenous Superphosphates and Guanos, Sampled by the Station.

Station. No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's statement of average cash price per ton.
2355	Pequot Fish and Potash.	Quinnipiac Co., New London, Ct.	Birdsey & Foster, Meriden.	$17.00	$20.00
2276	Kelsey's Fish and Potash.	E. R. Kelsey, Branford, Conn.	E. B. Payne, Cheshire.	25.00	20.00
			J. A. Bishop, N. Haven.	20.00	
			Nelson Hall, Meriden.	20.00	
2360	Quinnipiac Co's. Dry Ground Fish	Quinnipiac Co., New London, Ct.	Olds & Whipple, Hartford.	35.00	33.00–35.00
2359	Pure Fine Bone Dissolved in Sulphuric Acid.	Mapes Formula & Peruvian Guano Co., 158 Front St., N. Y.	Strong & Backus, Colchester.	32.00	
2356	Sanderson's Formula " A."	L. Sanderson, 119 Long Wharf, New Haven, Conn.	W. A. Thomas, Hamden Plains.	35.00	35.00
2282	Swift Sure Superphosphate.	M. L. Shoemaker & Co., Phila., Pa.	W. A. Thomas, Hamden Plains.	35.00	
			F. S. Ellsworth, Hartford.	38.00	
2339	Quinnipiac Fish and Potash, Plain Brand.	Quinnipiac Co., New London, Ct.	R. W. Burchard, Darien.	30.00	
			M. O. Babcock, Branford.	35.00	
2338	Pine Island Phosphate.	Quinnipiac Co., New London, Ct.	Filler & Hooper, Montville.	34.00	30.00–32.00
			M. O. Babcock, Branford.	35.00	
			H. J. Stanclift, New Hartford.	32.00	
2325	Ammoniated Dissolved Bone Phosphate.	Lister Agricultural Chemical Works, Newark, N. J.	A. N. Clark, Milford.	28.00	
			G. F. Fowler, N. Branford.	28.00	
			W. J. Munson, Watertown.	35.00	
2320	Flour of Bone Phosphate.	G. W. Miller, Middlefield, Conn.	M. K. Northam, Stony Creek.	38.00	
2283	Acme Fertilizer, No. 2.	C. Meyer, Jr., Maspeth, L. I.	J. & F. Beach, Branford.	40.00	43.00
			J. H. Ives, Danbury.	42.–45.	
2318	Great Planet A. Manure.	Clark's Cove Guano Co., New Bedford, Mass.	J. W. Boswell, Sterling.	37.–38.	
2316	Great Eastern General Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	C. A. Sharp, Abington.	38.00	
			W. R. Mapes, Putnam.	36.00	
			G. T. Sanger, Canterbury.	35.00	
			B. Seagrave, So. Canterbury.	36.00	
			C. B. Stearns, Andover.		

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's statement of average cash price per ton.
2326	Complete Manure for light soil.	Mapes Formula & Peruvian Guano Co., 158 Front St., N. Y.	Dean & Horton, Stamford.	$44.00	$44.00
			Mapes Branch, Hartford.	44.00	
			Birdsey & Foster, Meriden.	45.00	
2296	A. A. Ammoniated Superphosphate.	H. J. Baker & Bro., 215 Pearl St., N. Y.	Allen Betts, Norwalk.	37.00	...
			D. N. Benton, Guilford.	34.00	
			W. W. Cooper, Suffield.	37.50	
			A. L. Winton, Bridgeport.	37.50	
2327	Complete Manure for General Use.	Mapes Formula & Peruvian Guano Co., 158 Front St., N. Y.	Dean & Horton, Stamford.	39.00	39.00
			Mapes Branch, Hartford.	39.00	
2266	Ammoniated Bone Superphosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	W. H. Anderson, Putnam.	35.00	....
			J. M. Belden, New Britain	31.00	
			W. F. Andross, E. Hartford.	35.00	
			E. B. Clark, Milford.	29.–30.	
			Hubbell & Bradley, Saugatuck.	30.00	
			W. R. McDonald, Cromwell.	31.00	
2261	Chittenden's Ammoniated Bone Superphosphate.	National Fertilizer Co., Bridgeport, Conn.	Andrew Ure, Hamden.	28.00	....
			F. P. Burr & Co., Middletown.	34.00	
			David Fitzgerald, Stratford.	33.00	
			J. H. French, Cheshire.	34.00	
			G. W. Eaton, Plainville.	33.00	
			Clarence Swan, Bridgeport.	35.00	
			E. A. Buck & Co., Willimantic.	30.00	
			Balch & Platt, West Winsted.	35.00	
			M. Kinney, Putnam.	34.00	
2256	Americus Ammoniated Bone Superphosphate.	Williams & Clark Co., Hanover Square, New York.	W. E. Payne, Rockville.	32.00	35.00
			C. S. Gillette, Cheshire.	34.00	
			J. O. Fox, Putnam.	34.00	
			I. W. Beers, Hamden.	36.00	
			J. A. Paine, Danielsonville.	....	
			W. Kyle, Bethel.	36.00	
			D. B. Wilson & Co., Waterbury.	36.00	
			W. G. & F. Comstock, E. Hartford.	36.00	

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's statement of average cash price per ton.
2292	Chittenden's Fish and Potash.	National Fertilizer Co., Bridgeport, Conn.	E. A. Buck & Co., Willimantic.	$30.00	
			G. W. Eaton, Plainville.	34.00	
			W. W. Cooper, Suffield.	34.00	
			J. H. French, Cheshire.	35.00	
2332	Fish and Potash.	G. W. Miles, Agent, Milford, Conn.	J. D. Toomey, Fairfield.	30.00	$32.00–34.00
2324	Standard Superphosphate.	Lister Agricultural Chemical Works, Newark, N. J.	W. H. Parmelee, Essex.	35.00	----
			W. J. Munson, Watertown.	35.00	
			G. W. Dennison, Saybrook.	35.00	
			A. N. Clark, Milford.	32.00	
2278	Bay State Fertilizer.	Clark's Cove Guano Co., New Bedford, Mass.	J. B. Cowan, So. Coventry.	36.00	----
			H. F. Standish, Andover.	34.00	
			W. Tillinghast, Plainfield.	37.00	
2314	Quinnipiac Phosphate.	Quinnipiac Co., New London, Ct.	Martin Bros., Wallingford.	35.00	
			Birdsey & Foster, Meriden.	36.00	
			Daniel Moriarty, So. Meriden.	38.00	
			Alden Hill, No. Branford.	38.00	
			M. O. Babcock, Branford.	38.00	
			Southington Lumber and Feed Co., Southington.	36.50	
			J. C. Nettleton, Madison.	37.00	
			P. & G. M. Williams, New London,	32.50	
			D. N. Benton, Guilford.	33.00	
			Chandler & Morse, Putnam.	34.00	
			J. E. Hall, Colchester.	32.00	
			Olds & Whipple, Hartford.	37.00	
			J. M. Belden, New Britian.	36.00	
			D. C. Wood, Stratford.	36.00	
			Staples & Raymond, Westport.	36.00	
			R. W. Burchard, Darien.	37.00	
			Benj. Beers, Redding Center.	36.00	
			E. A. Godfrey, Bridgeport.	35.00	
			J. F. Silliman & Co., New Canaan.	38.00	

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's statement of average cash price per ton.
2270	Complete Manure A. Brand.	Mapes Formula & Peruvian Guano Co., 158 Front St., N. Y.	Dean & Horton, Stamford.	$36.00	----
			W. R. Foot, Branford.	37.00	
			Wilson & Burr, Middletown.	36.00	
			Birdsey & Foster, Meriden.	37.00	
			David Beers, Danbury.	38.00	
			D. B. Wilson & Co., Waterbury.	38.00	
			Mapes Branch, Hartford.	36.00	
			Quinnebaug Store, Danielsonville.	37.00	
2231	I. X. L. Ammoniated Bone Superphosphate.	G. W. Miles, Agt., Milford, Ct.	W. E. Wheeler, Mystic River.	33.00	$28.00–32.00
			J. P. Barstow & Co., Norwich.	30.00	
			J. D. Toomey, Fairfield.	30.00	
			A. H. Hinckley, Mystic.	29.00	
2235	Orient Complete Manure.	Orient Guano Mfg. Co., Orient, L. I.	Mrs. F. Shanley, Torrington.	29.00	----
			F. P. Burr & Co, Middletown.	30.00	
			A. B. Morse, Guilford.	29.00	
			G. W. Eaton, Plainfield.	28.00	
2253	Standard Pure Bone Superphosphate.	H. S. Miller & Co., Newark, N. J.	G. W. Dennison, Saybrook.	35.00	----
			R. W. Cowles, Plantsville.	38.00	
2288	Victor Phosphate.	Apothecaries Hall Co., Waterbury, Conn.	Manufacturer.	30.00	
2257	Farmer's New Method Fertilizer.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	A. J. Ives, Meriden.	32.00	32.00
			D. B. Judd & Co., Bristol.	32.00	
			W. F. Andross, E. Hartford.	33.00	
			J. R. Cogswell, Putnam.	32.00	
			I. W. Beers, Hamden.	32.00	
			R. A. Parker, Warehouse Point.	33.00	
			M. Beach & Son, New Milford.	35.00	
			C. S. Gillette, Cheshire.	32.00	
			T. Pease & Sons Co., Windsor Locks.	35.00	
			W. B. Martin, Rockville.	35.00	

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's statement of average cash price per ton.
2259	Bowker's Hill and Drill Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	E. J. Dickerman, Mt. Carmel.	$40.00	----
			W. F. Andross, E. Hartford.	37.00	
			J. A. Paine, Danielsonville.	----	
			Dunham & Co., W. Cheshire.	38.00	
			F. Hallock & Co., Birmingham.	36.00	
			T. Pease & Sons Co., Windsor Locks.	37.00	
			Hubbell & Bradley, Saugatuck.	35.00	
			W. H. Anderson, Putnam.	38.00	
			J. M. Belden, New Britain.	35.00	
2294	Cumberland Superphosphate.	Cumberland Bone Co., Portland, Me.	J. M. Williams, Manchester.	35.00	$36–38
			W. Tillinghast, Plainfield.	37.00	
			E. E. Salisbury, Moosup.	38.00	
2273	Quinnipiac Fish and Potash "Crossed Fishes."	Quinnipiac Co., New London, Ct.	E. J. Dickerman, Mt. Carmel.	37.00	----
			Daniel Moriarty, So. Meriden.	36.00	
			Olds & Whipple, Hartford.	36.00	
			J. F. Silliman & Co., New Canaan.	38.00	
			Wilson & Burr, Middletown.	35.00	
			M. O. Babcock, Branford.	36.00	
2279	Ammoniated Bone Superphosphate.	Russell Coe, Tremley, N. J.	W. Tillinghast, Plainfield.	32.00	----
			S. J. Hall, Meriden.	30.00	
			Wilson & Burr, Middletown.	30.00	
2248	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport, Conn.	David Fitzgerald, Stratford.	41.40	----
			J. H. French, Cheshire.	43–44	
			Balch & Platt, West Winsted.	45.00	
			W. B. Martin, Rockville.	45.00	
			W. W. Cooper, Suffield.	40.00	
			L. W. Currier, Bridgeport.	45.00	
2207	Bradley's Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	From stock bought by Green's Farms Farmer's Club.	35.00	35.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's average cash price per ton.
2246	Bradley's Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	M. H. Tanner & Co., Winsted.	$37.00	$35.00
			W. F. Andross, East Hartford.	37.50	
			Raymond Bros., So. Norwalk.	36.00	
			W. W. Cooper, Suffield.	38.00	
			T. Pease & Sons Co., Windsor Locks.	36.00	
			R. A. Parker, Warehouse Point.	35.00	
			M. Beach & Son, New Milford.	38.00	
			W. B. Martin, Rockville.	38.00	
			A. A. Hubbard, Canaan.	37.00	
			Ruggles & Clark, Shelton.	37.00	
			E. E. Scofield, Stamford.	38.00	
			Warner & Clark, Sandy Hook.	36.00	
2212	Fish & Potash, "Anchor Brand."	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Sanford & Hawley, Unionville.	35.00	32.00
			Strong & Backus, Colchester.	30.00	
			D. B. Judd & Co., Bristol.	32.00	
			A. J. Ives, Tracy.	32.00	
			C. S. Gillette, Cheshire.	30.00	
2271	High Grade Ammoniated Bone Superphosphate.	E. Frank Coe, 16 Burling Slip, N. Y.	H. W. Elliott, No. Haven.	36.00	36–37
			F. P. Burr & Co., Middletown.	34.00	
			Cochrane Bros., W. Cornwall.	34.00	
			Simon Banks, Southport.	34.00	
			Ruggles & Clark, Shelton.	35.00	
2210	Original Coe's Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Cochrane Bros., W. Cornwall.	32.00	----
			S. E. Rose, Quarryville.	36.00	
2281	Bosworth Bone Superphosphate.	Chas. Prentice, Putnam, Conn.	Manufacturer.	34.00	----
2272	Darling's Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	R. P. Hubbard, Middletown.	34–35	36.00
			W. S. Vinton, Coventry.	36.00	
			T. Pease & Sons Co., Windsor Locks.	37.00	
			J. M. Belden, New Britain.	35.00	
			W. W. Cooper, Suffield.	37.50	
			H. K. Brainard, Thompsonville.	36.00	
			Dunham & Co., W. Cheshire.	36.00	

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's statement of average cash price per ton.
2260	Soluble Pacific Guano.	Soluble Pacific Guano Co., Boston, Mass.	Dunham & Co., W. Cheshire.	$35.00	----
			J. M. Belden, New Britain.	35.00	
			E. A. Buck & Co., Willimantic.	33.00	
			R. W. Burchard, Darien.	38.00	
2311	Extra Fine Ground Bone with Potash.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	J. L. Butler, Torrington.	40.00	$32.00
			E. E. Spicer, Groton.	34.00	
2334	Peruvian Guano, Cargo Strathorne.	Mapes' Formula and Peruvian Guano Co., 158 Front St., N. Y.	Mapes Branch, Hartford.	60.00	60.00
2269	Ammoniated Bone Superphosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	A. H. Dimond, Bethel.	----	37-38
			H. K. Brainard, Thompsonville.	36.00	
			E. Hill, Moosup.	----	
			L. D. Post, Andover.	35.00	
			W. Tillinghast, Plainfield.	37.00	
			J. M. Belden, New Britain.	37.00	
2293	Darling's Extra Bone Phosphate.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	T. Pease & Sons' Co., Windsor Locks.	37.00	----
			W. S Vinton, Coventry.	36.00	
			Quinnebaug Store, Danielsonville.	35.00	
2313	Fish & Potash—A Brand.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Raymond Bros., South Norwalk.	31.00	32.00
			C. B. Dokin, Sharon.	32.00	
2290	Cecrops Fertilizer.	Newton & Ludlam, 182 Front St., N. Y.	Young & Vaughn, Danielsonville.	43.00	----
			H. B. Todd & Son, Wallingford.	43.00	
2309	Sea Fowl Guano.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	W. W. Cooper, Suffield.	38.00	----
2265	Bowker's Fish and Potash.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	E. J. Dickerman, Mt. Carmel.	35.00	----
			W. R. McDonald, Cromwell.	31.00	
			C. W. Michaels, Yalesville.	34. & 35.	
			A. S. Russell & Co., Meriden.	30.00	
			J. M. Belden, New Britain.	32.00	
			T. Pease & Sons' Co., Windsor Locks.	32.00	
			Durham & Co., West Cheshire.	35.00	

Nitrogenous Superphosphates and Guanos, Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's statement of average cash price per ton.
2317	King Philip Alkaline Guano.	Clark's Cove Guano Co., New Bedford, Mass.	W. F. Bailey, Bozrahville.	$28.00	
			T. Pease & Sons' Co., Windsor Locks.	32.00	
2358	Ammoniated Bone Phosphate.	David Dickinson, Middle Haddam.	S. H. Emmons, Moodus.	38.00	$36.00
2348	Standard Superphosphate.	A. Mitchell, Tremley, N. J.	S. E. Brown, Pawcatuck Bridge.	38.00	----
			Edward Fly, Putnam.	36.00	
2303	High Grade Ammoniated Bone Superphosphate.	William P. Adams, 248 Front St., N. Y.	G. Thompson, Essex.	35.00	----
			C. E. Chapman, Westbrook.	36.00	
			J. E. Leonard, Jewett City.	37.00	
			F. H. Tillinghast, Central Village.	38.00	
2289	Standard Superphosphate.	Standard Fertilizer Co., Boston, Mass.	Allen Wilson, Suffield.	38.00	----
2277	Fish and Potash.	Soluble Pacific Guano Co., Boston, Mass.	W. B. Martin, Rockville.	32.00	----
			Dunham & Co., West Cheshire.	33.00	
			B. Curtis & Son, Stepney Depot.	33.00	
2287	Ammoniated Bone Superphosphate.	H. Preston & Sons, Greenpoint, L. I.	J. B. Merrow & Son, Merrow.	34.00	----
			A. L. Hodge & Son, Roxbury Station.	32.00	
2291	Cereal Fertilizer.	Newton & Ludlam, 182 Front St., New York.	E. Fly, Putnam.	36.00	----
			Young & Vaughn, Danielsonville.	33.00	
			H. B. Todd & Son, Wallingford.	33.00	
2342	Royal Bone Phosphate.	Williams & Clark Co., Hanover Square, N. Y.	B. E. Johnson, Higganum.	27.00	----
			Dimmock & Brown, New London.	26.00	
			H. K. Brainard, Thompsonville.	25.00	
2319	Alkaline Bone.	E. Frank Coe, 16 Burling Slip, N. Y.	H. W. Elliott, North Haven.	33.00	32–34
			H. L. Hall, Jr., Wallingford.	35.00	
2320	Red Brand, Excelsior Guano.	E. Frank Coe, 16 Burling Slip, N.Y.	F. P. Burr & Co., Middletown.	44.00	43–45

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's statement of average cash price per ton.
2357	The $25.00 Phosphate.	Baugh & Sons' Co., Philadelphia, Penn.	T. R. Dawley, Griswold.	$30.00	----
2390	Davidge's Special Favorite.	Davidge Fertilizer Co., New York.	Prentice & Young, Norwich.	35.00	----
			Young & Vaughn, Danielsonville.	35.00	
			N. C. Barker & Co., Lebanon.	33.00	
			H. J. Stanclift, New Hartford.	34.00	
			Smith & Caulkins, New Lebanon.	32.00	
			E. E. Hill, Moosup.	----	
2321	High Grade Fish Guano and Potash.	E. Frank Coe, 16 Burling Slip, N. Y.	Ruggles & Clark, Shelton.	35.00	----
			F. P. Burr & Co., Middletown.	34.00	
2302	Adams' Lion Brand Fish and Potash.	William P. Adams, 248 Front St., N. Y.	W. S. Ellis, Gilead.	33.00	----
			G. Thompson, Essex.	35.00	
			L. M. Clark, Monroe.	38.00	
2322	Queen City Phosphate.	Crocker Fertilizer and Chemical Works, Buffalo, N. Y.	G. H. Clark, Salisbury.	35.00	$37.00
2340	Economical Bone Fertilizer.	Wilkinson & Co., 239 Center St., N. Y.	W. A. Smith, Groton.	32.00	32.00
			A. L. Anderson & Son, Tolland.	32.00	
			Southington Lumber and Feed Co., Southington.	30.40	

Analyses of Nitrogenous Superphosphates, Sampled by the Station.

Station No.	Name or Brand.	Nitrogen					Phosphoric Acid.							Potash.			Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found	Total Guaranteed.	Available. Found	Available. Guaranteed	Found.	Guaranteed.	Chlorine.			
2355	Quinnipiac Co's Pequot Fish and Potash	....	.75	2.32	3.07	*2.5*	.26	4.85	2.88	7.99	....	5.11	*3.0*	4.65	*4.0*	...	$17.00	$23.65	28.1*
2276	Kelsey's Fish and Potash	....	.60	3.73	4.33	*2.5*	.89	1.83	.36	3.08	*3.0*	2.72	....	3.29	*3.0*	3.24	20.00	21.60	7.1*
2360	Quinnipiac Co's Dry Ground Fish	....	.26	8.56	8.82	*7.5*	.97	4.10	1.83	6.90	....	5.07	*4.0*	....	....	....	35.00	37.96	7.7*
2359	Mapes' Pure Fine Bone, Dissolved	....	.46	2.55	3.01	*2.0*	4.79	11.45	1.56	17.80	....	16.24	*12.0*	....	....	....	32.00	35.80	1.6*
2356	Sanderson's Formula "A"	.54	.24	2.62	3.40	*3.2*	6.04	3.83	1.80	11.67	*10.0*	9.87	*6.0*	7.37	*6.0*	....	35.00	34.26	2.1
2238	Shoemaker's Swift-Sure Superphosphate	.90	....	2.67	3.57	*2.5*	7.56	3.83	2.72	14.11	....	11.39	*9.0*	4.65	*4.0*	tr'ce	38.00	36.26	4.7
2339	Quinnipiac Fish and Potash, Plain Brand	....	.26	2.88	3.14	*2.0*	....	7.54	3.40	10.94	*6.0*	7.54	*4.0*	5.17	*4.0*	7.71	30.00	28.15	6.6
2338	Quinnipiac Co's Pine Island Phosphate	.24	.28	2.04	2.56	*2.0*	2.47	10.07	2.03	14.57	....	12.54	*9.0*	1.51	*1.0*	3.41	32.00	30.03	6.6
2325	Lister's Ammoniated Dissolved Bone Phosphate	....	.44	1.52	1.96	*1.8*	7.74	3.11	1.36	12.21	....	10.85	*9.0*	1.67	*1.5*	.94	28.00	25.95	7.9
2330	G. W. Miller's Flour of Bone Phosphate	.63	.23	3.02	3.88	*2.4*	....	10.25	.14	10.39	*12.0*	10.25	*11.0*	7.29	*4.8*	9.23	38.00	34.50	10.1
2333	Meyer's Acme Fertilizer, No. 2	.63	3.32	1.33	5.28	*5.0*	3.88	4.44	1.56	9.88	....	8.32	*8.0*	6.52	*5.0*	.26	43.00	38.93	10.4
2318	Great Planet A Manure	1.10	1.41	.57	3.08	*3.0*	6.88	2.07	1.09	10.04	*8.3*	8.95	*7.3*	9.31	*9.5*	7.61	37.00	33.02	12.
2316	Great Eastern General Fertilizer	.71	.13	2.58	3.42	*3.0*	5.33	5.71	2.91	13.95	....	11.04	*8.0*	2.21	*2.0*	2.35	36.00	31.97	12.6
2326	Mapes' Complete Manure for light soil	.83	2.46	2.40	5.69	*5.0*	3.43	5.04	1.66	10.13	*8.0*	8.47	*6.0*	6.84	*6.0*	6.48	44.00	39.05	12.7
2296	Baker's "AA" Ammoniated Superphosphate	....	2.22	1.05	3.27	*2.5*	11.35	.27	.02	11.64	....	11.62	*10.0*	2.95	*2.0*	2.05	36.50	32.21	13.3

* Valuation exceeds cost.

ANALYSES OF NITROGENOUS SUPERPHOSPHATES, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found	Total Guaranteed.	Available. Found	Available. Guaranteed	Found.	Guaranteed.				
2327	Mapes' Complete Manure for general use	.72	.84	2.17	3.73	*3.3*	5.10	5.09	2.28	12.47	*10.0*	10.19	....	4.95	*4.0*	3.36	$39.00	$33.78	15.4
2266	Bowker's Ammoniated Bone Superphosphate	....	.09	1.98	2.07	*1.5*	8.66	2.26	2.64	13.56	*11.0*	10.92	*10.0*	1.13	*1.0*	1.95	31.00	26.64	16.4
2261	Chittenden's Ammoniated Bone Superphosphate	....	.12	2.14	2.26	*1.6*	5.04	5.63	3.57	14.24	*9.0*	10.67	*7.0*	2.59	*2.0*	2.79	33.00	28.33	16.4
2256	Americus Ammoniated Bone Superphosphate	....	.98	1.83	2.81	*2.0*	9.79	.96	.32	11.07	*11.0*	10.75	....	3.07	*2.0*	.29	35.00	30.04	16.5
2292	Chittenden's Fish and Potash	....	....	3.52	3.52	*3.3*	.98	4.64	5.72	11.34	*6.0*	5.62	....	5.43	*5.0*	5.49	33.00	28.20	17.
2332	Miles' Fish and Potash	....	.18	2.12	2.30	*2.5*	6.65	2.41	.64	9.70	....	9.06	*5.0*	3.94	*3.0*	4.65	30.00	25.61	17.1
2324	Lister's Standard Superphosphate	....	.66	1.96	2.62	*2.0*	8.07	3.09	1.47	12.63	....	11.16	*10.0*	1.84	*1.5*	1.96	34.00	28.77	18.2
2278	Bay State Fertilizer	....	1.10	1.64	2.74	*2.1*	8.58	1.72	1.96	12.26	*9.5*	10.30	*8.0*	3.00	*2.0*	1.32	35.00	29.61	18.2
2314	Quinnipiac Phosphate	.44	....	2.74	3.18	*2.8*	8.44	1.92	.90	11.26	....	10.36	*9.0*	2.60	*2.0*	2.35	35.00	29.56	18.4
2270	Mapes' Complete Manure, "A" Brand	.34	.77	1.74	2.85	*2.5*	5.16	4.78	3.92	13.86	....	9.94	*10.0*	3.20	*2.5*	4.40	36 00	30.03	19.8
2331	Miles' I. X. L. Ammoniated Bone Superposphate	....	.24	1.74	1.98	*2.0*	8.07	2.04	.72	10.83	....	10.11	*8.0*	2.31	*1.0*	2.20	30.00	24.94	20.3
2335	Orient Complete Manure	....	....	2.10	2.10	*1.7*	8.98	.59	.41	9.98	....	9.57	*8.0*	1.95	*2.0*	1.52	29.00	24.09	20.3
2352	H. S. Miller's Standard Bone Superphosphate	....	.18	2.50	2.68	*2.4*	11.35	.21	.07	11.63	....	11.56	*10.0*	3.30	*1.5*	....	36.50	30.19	20.9
2288	Victor Phosphate	....	....	....	2.62	...	7.55	1.13	.33	9.01	....	8.68	....	2.43	....	2.25	30.00	24.69	21.5
2257	Bradley's Farmers' New Method Fertilizer	....	.12	2.08	2.20	*1.7*	8.47	1.58	1.29	11.34	*10.0*	10.05	*8.0*	2.77	*3.0*	2.86	32.00	26.32	21.6
2259	Bowker'sHill and Drill Phos.	.36	.29	2.01	2.66	*2.5*	8.47	2.64	2.53	13.64	*11.0*	11.11	*10.0*	1.99	*2.0*	1.75	36.00	29.53	21.8
2294	Cumberland Superphosphate	.42	.44	1.66	2.52	*2.0*	7.03	3.97	3.40	14.40	*11.0*	11.00	*8.0*	2.69	*2.0*	.96	37.00	30.25	22.3
2273	Quinnipiac Fish and Potash, Crossed Brand	....	.48	3.53	4.01	*3.3*	.36	5.04	4.37	9.77	*5.0*	5.40	*3.0*	5.13	*3.0*	7.10	35.00	28.46	22.9

Analyses of Nitrogenous Superphosphates, Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
2279	Russell Coe's Ammoniated Bone Superphosphate	....	1.32	1.19	2.51	*2.0*	6.36	2.25	1.24	9.85	*9.0*	8.61	*8.0*	2.80	*1.0*	5.02	$31.00	$25.22	22.9
2248	Chittenden's Complete Fertilizer	.58	....	3.03	3.61	*3.3*	3.41	6.68	4.13	14.22	*8.0*	10.09	*6.0*	5.65	*6.0*	5.64	43.00	34.62	24.2
2207	Bradley's Superphosphate	.33	.17	2.24	2.74	*2.3*	8.19	2.16	1.73	12.08	....	10.35	*9.0*	2.06	*1.5*	2.05	35.00	28.16	24.3
2246	Bradley's Superphosphate	.31	....	2.47	2.78	*2.3*	8.32	1.92	1.70	11.94	....	10.24	*9.0*	2.11	*1.5*	2.20	35.00	28.14	24.3
2312	Bradley's Fish and Potash, Anchor Brand	....	.22	3.34	3.56	*3.3*	3.84	1.73	1.46	7.03	*5.0*	5.57	*3.0*	4.08	*3.0*	8.68	31.00	24.88	24.6
2271	Coe's High Grade Ammoniated Bone Superphosphate	....	.60	1.77	2.37	*2.0*	8.49	1.68	1.88	12.05	*10.0*	10.17	*9.0*	2.54	*3.0*	.31	35.00	27.86	25.6
2310	Original Coe's Superphosphate	....	....	2.16	2.16	*2.1*	8.71	2.03	1.18	11.92	*10.0*	10.74	*8.0*	2.52	*1.0*	2.64	34.00	26.97	26.
2281	Bosworth Bone Superphosphate	....	1.34	1.01	2.35	*2.0*	3.57	3.65	7.41	14.63	....	7.22	*11.0*	3.72	*2.0*	3.58	34.00	26 81	26.4
2272	Darling's Animal Fertilizer	....	.48	2.96	3.44	*3.3*	2.35	4.04	4.49	10.88	*10.0*	6.39	....	5.24	*4.0*	5.54	36.00	28.41	26.7
2260	Soluble Pacific Guano	....	.30	2.29	2.59	*2.0*	6.76	2.81	2.67	12.24	....	9.57	*8.0*	2.72	*2.0*	3.11	35.00	27.56	26.9
2311	Bradley's Extra Fine Ground Bone with Potash	....	....	2.09	2.09	*1.8*	3.67	6.00	2.75	12.42	*8.0*	9.67	....	2 07	*2.0*	2.28	32.00	25.18	27.
2334	Mapes' Peruvian Guano	.06	5.72	1.18	6.96	*7.8*	7.56	4.67	1.97	14.20	*14.0*	12.23	....	3.13	*2.6*	4.35	60.00	47.14	27.3
2269	Crocker's Ammoniated Bone Superphosphate	....	....	3.16	3.16	*2.9*	7.76	2.08	1.16	11.00	*8.0*	9.84	....	1.62	*1.0*	1.26	36.00	28.04	28.3
2293	Darling's Extra Bone Phosphate	.20	.48	2.39	3 07	*2.5*	3.92	3.45	3.50	10.87	*10.0*	7.37	....	5.03	*3.0*	4.50	36.00	28.01	28.5
2313	Bradley's Fish and Potash "A" Brand	....	.42	2.89	3.31	*2.0*	3.02	2.65	2.26	7.93	*6.0*	5.67	*4.0*	3.90	*4.0*	6.21	31.50	24.50	28.5
2290	Cecrops Fertilizer	.58	.22	2.42	3.22	*3.2*	7.02	3.17	3.18	13.37	....	10.19	*7.0*	5.48	*7.0*	5.37	43.00	33.18	29.5
2309	Bradley's Sea Fowl Guano	....	....	2.48	2.48	*2.5*	8.92	2.73	1.24	12.89	*11.0*	11.65	*9.0*	2 23	*2.0*	1.91	38.00	29.28	29.8
2265	Bowker's Fish and Potash	....	.09	1.95	2.04	*2.2*	3.56	3.21	6.79	13.56	*8.0*	6.77	....	3.54	*4.0*	3.82	32.00	24.35	31.4

Analyses of Nitrogenous Superphosphates, Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
2317	King Philip Alkaline Guano	.17	.35	1.26	1.78	*1.2*	4.65	2.98	3.32	10.95	*7.5*	7.63	*6.5*	2.61	*3.0*	1.04	$30.00	$22.35	34.2
2358	Dickinson's Ammoniated Bone Superphosphate	....	.06	3.21	3.27	*4.0*	5.84	4.34	2.68	12.86	*13.0*	10.18	....	....	....	....	38.00	28.26	34.4
2343	Mitchell's Standard Superphosphate	.12	.23	2.06	2.41	*2.0*	8.12	2.17	.26	10.55	*11.5*	10.29	*9.0*	2.86	*2.5*	....	37.00	27.41	35.
2303	Adams' High Grade Ammoniated Bone Superphosphate	....	.33	1.84	2.17	*2.5*	4.77	4.72	1.54	11.03	....	9.49	*10.0*	4.18	*7.0*	1.41	36.50	26.99	35.2
2289	Standard Superphosphate	....	.48	2.29	2.77	*2.5*	7.38	2.52	2.29	12.19	*11.0*	9.90	*9.0*	2.18	*2.0*	3.12	38.00	28.04	35.5
2277	Soluble Pacific Guano Co's. Fish and Potash	....	....	2.43	2.43	*2.5*	4.87	1.66	2.63	9.16	*6.0*	6.53	*4.0*	4.78	*4.0*	7.71	32.50	23.94	35.7
2337	Preston's Ammoniated Bone Superphosphate	....	.37	1.72	2.09	*2.5*	4.69	2.64	2.99	10.32	....	7.33	*9.0*	3.66	*2.0*	.31	33.00	24.16	36.6
2291	Cereal Fertilizer	....	....	1.28	1.28	*1.3*	8.41	2.37	4.60	15.38	*11.0*	10.78	*10.0*	1.02	*4.0*	1.43	34.00	24.88	36.6
2342	Williams & Clark Co's Royal Bone Phosphate	....	....	1.49	1.49	*0.5*	5.19	2.61	1.14	8.94	*8.0*	7.80	....	2.28	*2.0*	....	28.00	20.19	38.6
2319	Coe's Alkaline Bone	....	.07	1.33	1.40	*.8*	8.57	2.05	1.74	12.36	*10.0*	10.62	*9.0*	1 85	*3.0*	.23	34.00	24.41	39.3
2320	Coe's Excelsior Guano. Red Brand	....	.79	2.49	3.28	*3.3*	7.77	1.22	.69	9.68	*10.0*	8.99	....	5.18	*11.0*	.50	44.00	31.18	41.2
2357	Baugh&Son's $25 Phosphate	....	....	1.97	1.97	*2.0*	6.63	1.44	3.10	11.17	....	8.07	*7.0*	....	....	....	30.00	21.13	41.9
2390	Davidge's Special Favorite	....	.12	1.49	1.61	*1.2*	9.08	1.55	.38	11.01	*12.0*	10.63	*10.0*	1.71	*1.5*	1.48	34.00	23.87	42.4
2321	Coe's High Grade Fish Guano and Potash	....	.20	2.30	2.50	*3.3*	3.59	3.97	2.49	10.05	....	7.56	*6.0*	3.01	*4.0*	6.19	34.50	24.04	43.5
2302	Adams' Lion Brand Fish and Potash	....	....	2.38	2.38	*2.5*	4.06	3.58	.96	8.60	*6.0*	7.64	*3.0*	4.57	*8.0*	4.30	35.00	24.18	44.7
2322	Queen City Phosphate	....	....	1.94	1.94	*1.7*	7.64	2.17	.93	10.74	....	9.81	*8.0*	1 40	*2.0*	1.46	35.00	23.63	48.1
2340	Wilkinson's Economical Bone Fertilizer	.19	.76	.42	1.37	*1.2*	5.60	1.46	1.13	8.19	*6.0*	7.06	....	2.84	*2.0*	.58	32.00	19.40	64.9

Fish and Potash.—Sampled by the Station.

	Quinnipiac Pequot.	Kelsey's.	Quinnipiac Plain Brand.	Chittenden's.	Miles'.	Quinnipiac Crossed Brand.	Bradley's Anchor Brand.	Bradley's A Brand.	Bowker's.	Soluble Pacific Guano Co's.	Coe's.	Adams' Lion Brand.
	2355	2276	2339	2292	2332	2273	2312	2313	2265	2277	2321	2302
Nitrogen as Ammonia	.75	.60	.26	....	.18	.48	.22	.42	.09	....	.20	....
Nitrogen, Organic	2.32	3.73	2.88	3.52	2.12	3.53	3.34	2.89	1.95	2.43	2.30	2.38
Soluble Phosphoric Acid	.26	.89	....	.98	6.65	.36	3.84	3.02	3.56	4.87	3.59	4.06
Reverted Phosphoric Acid	4.85	1.83	7.54	4.64	2.41	5.04	1.73	2.65	3.21	1.66	3.97	3.58
Insoluble Phosphoric Acid	2.88	.36	3.40	5.72	.64	4.37	1.46	2.26	6.79	2.63	2.49	.96
Potash	4.65	3.29	5.17	5.43	3.94	5.13	4.08	3.90	3.54	4.78	3.01	4.57
Cost	$17.00	$20.00	$30.00	$33.00	$30.00	$35.00	$31.00	$31.50	$32.00	$32.50	$34.50	$35.00
Valuation	23.65	21.60	28.15	28.20	25.61	28.46	24.88	24.50	24.35	23.94	24.04	24.18
Nitrogen found	3.07	4.33	3.14	3.52	2.30	4.01	3.56	3.31	2.04	2.43	2.50	2.38
Nitrogen guaranteed	2.5	2.5	2.0	3.3	2.5	3.3	3.3	2.0	2.2	2.5	3.3	2.5
Phosphoric Acid found	7.99	3.08	10.94	11.34	9.70	9.77	7.03	7.93	13.56	9.16	10.05	8·60
Phosphoric Acid guaranteed	....	3.0	6.0	6.0	....	5.0	5.0	6.0	8.0	6.0	....	6.0
Potash found	4.65	3.29	5.17	5.43	3.94	5.13	4.08	3.90	3.54	4.78	3.01	4.57
Potash guaranteed	4.0	3.0	4.0	5.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0	8.0

2. *Manufacturers' Samples.*

The fertilizers named below were not found by the Station agents in any stocks which they inspected, and accordingly the analyses were made on samples deposited at the Station by manufacturers.

2344. Unicorn Fertilizer and **2345** Great Planet B. Fertilizer are made by the Clark's Cove Guano Co., New Bedford.

2348. Crocker's Superphosphate, No. 2, made by the Crocker Fertilizer and Chemical Works, Buffalo, N. Y.

2394. Ammoniated Dissolved Bone Phosphate, made by H. S. Miller & Co., Newark, New Jersey.

Analyses and Valuations.

	2344	2345	2348	2394
Nitrogen as nitrates	....	1.86	....	....
Nitrogen as ammonia	.17	2.00	....	.85
Organic nitrogen	2.42	1.11	.38	1.58
Total Nitrogen found	2.59	4.97	.38	2.43
Nitrogen guaranteed	1.8	4.9	....	1.7
Soluble phosphoric acid	6.70	5.54	9.90	8.61
Reverted phosphoric acid	2.33	1.09	2.70	1.19
Insoluble phosphoric acid	3.62	.60	1.77	.67
Total phosphoric acid found	12.65	7.23	14.37	10.47
Phosphoric acid guaranteed	10.0	6.0	13.00	....
Available phosphoric acid found	9.03	7.23	12.60	9.80
Available phosphoric acid guaranteed	8.05	5.0	11.00	8.0
Potash	2.55	7.32	1.43	3.04
Potash, guaranteed	2.25	7.0	1.36	1.5
Chlorine	1.24	2.04	1.52	.78
Valuation per ton	$27.34	34.83	23.41	27.23

3. *Sampled by private individuals.*

2284. Chittenden's Ammoniated Bone Superphosphate.*

2285. Chittenden's Fish and Potash.†

2286. Chittenden's Complete Fertilizer.‡ All made by the National Fertilizer Co., Bridgeport. Sampled and sent by Thos. R. Atwood, Newington.

* See also analysis of same brand, p. 60, No. 2261.

† See also analysis of same brand, p. 60, No. 2292.

‡ See also analysis of same brand, p. 61, No. 2248.

Analyses and Valuations.

	2284	2285	2286
Nitrogen as nitrates	.41	....	2.07
Nitrogen as ammonia	.13	.13	none
Organic nitrogen	2.58	3.93	2.50
Soluble phosphoric acid	5.04	3.92	5.01
Reverted phosphoric acid	4.46	3.45	3.80
Insoluble phosphoric acid	3.54	3.25	3.41
Potash	4.18	6.19	6.64
Chlorine	4.28	6.38	6.73
Cost per ton	$30.00	30.00	39.00
Valuation per ton	30.70	32.08	36.28

II. Special Manures, sampled by Station Agents.

[For tables of analyses, etc., see pages 66–72.]

Here are included such nitrogenous superphosphates as are claimed by their manufacturers to be specially adapted to the needs of particular crops. In previous reports the justice of such claims has been discussed.

Guarantees.—Nine samples are below guarantee on one ingredient and two samples on two ingredients, making a third of the whole number which fail to come up to their minimum guarantee.

COST AND VALUATION. The average cost of the Special Manures has been $39.47, and the average valuation $33.99. The difference between cost and valuation is $5.48 and the percentage difference 16.1. The corresponding difference in case of the superphosphates (see page 49) was 20.3 per cent. This year, as heretofore, the Special Manures as a class have been higher-priced than the other nitrogenous superphosphates, more concentrated, and if the quality of the raw materials composing them is equally good, more economical to purchase.

Special notice of certain analyses.—In Bulletin No. 95 the valuation of the Rogers & Hubbard Co.'s Complete Potato and Tobacco Manure, and Fairchild's Formula for Corn and General Crops was lower than in the following tables. The valuation was first made as on superphosphates. These brands, however, contain no soluble phosphoric acid, and as the source of the phosphoric acid was evidently raw bone and was so claimed by the manufacturer, the samples were mechanically analyzed after removing salts and the phosphoric acid valued as in bone. This raised the total valuation about two dollars in each case.

These two brands are mixtures of finely ground raw bone, nitrate of soda and sulphate of potash.

Special Manures, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's statement of average cash price per ton.
2186	The Rogers & Hubbard Co.'s Complete Manure for Potatoes and Tobacco.	The Rogers & Hubbard Co., Middletown, Conn.	Manufacturer.	$46.00	$46.00
2187	Fairchild's Formula for Corn and General Crops.	The Rogers & Hubbard Co., Middletown, Conn.	Manufacturer.	44.00	44.00
2249	Seeding Down Fertilizer.	Cumberland Bone Co., Portland, Me.	E. E. Salisbury, Moosup.	30.00	----
2315	Vegetable, Vine, and Tobacco Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	Clifton Peck, Lebanon.	34.00	----
			C. B. Stearns, Andover.		
			G. T. Sanger, Canterbury.	35.00	
			B. S. Gallup, Baltic.	34.00	
2308	Complete Manure for Top Dressing Grass and Grain.	Bradley Fertilizer Co, 27 Kilby St., Boston, Mass.	Burtis & Mead, New Canaan.	35.–36.	
2350	Tobacco Manure. Wrapper Brand.	Mapes' Formula and Peruvian Guano Co., New York.	Mapes Branch, Hartford.	46.00	46.00
2351	Fruit and Vine Manure.	Mapes' Formula and Peruvian Guano Co., New York.	Mapes Branch, Hartford.	38.00	38.00
2268	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	J. O. Lewis, Willimantic.	40.00	40.00
			M. H. Tanner & Co., Winsted.	41.00	
			Raymond Bros., South Norwalk.	40.00	
			W. F. Andross, East Hartford.	42.00	
			S. E. Rose, Quarryville.	40.00	
			David Beers, Danbury.	44.00	

SPECIAL MANURES, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's statement of average cash price per ton.
2329	Quinnipiac Potato Manure.	Quinnipiac Co., New London, Ct.	J. E. Leonard, Jewett City.	$38.00	
			Mrs. F. Shanley, Torrington.	35.00	
			Alden Hill, North Branford.	38.00	
			Filer & Hooper, Montville.	35.00	
			A. Williams, Collinsville.	36.00	
			D. N. Benton, Guilford.	35.00	
			H. J. Stanclift, New Hartford.	38.60	
			Chandler & Morse, Putnam.	36.00	
			Staples & Raymond, Westport.	37.00	
			D. C. Wood, Stratford.	37.00	
			Birdsey & Foster, Meriden.	38.00	
			J. M. Belden, New Britain.	38.00	
			R. W. Burchard, Darien.	38.00	
			Benj. Beers, Redding Center.	36.00	
			J. F. Silliman & Co., New Canaan.	38.00	
			E. J. Dickerman, Mt. Carmel.	40.00	
			E. A. Godfrey, Bridgeport.	37.00	
2275	Grass and Grain Top Dressing.	Mapes' Formula and Peruvian Guano Co., New York.	Dean & Horton, Stamford.	41.00	$41.00
			David Beers, Danbury.	43.00	
			Birdsey & Foster, Meriden.	42.00	
			Mapes Branch, Hartford.	41.00	
2205	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Bought by Green's Farms Farmers' Club.	*	40.00
2328	Tobacco Manure. Conn. Brand.	Mapes' Formula and Peruvian Guano Co., New York.	Wilson & Burr, Middletown.	44.00	44.00
			Mapes Branch, Hartford.	44.00	
2323	Potato Fertilizer.	Lister Agricultural Chemical W'ks, Newark, N. J.	W. H. Parmelee, Essex.	35.00	----
2377	Acme Potato Fertilizer.	C. Meyer, Jr., Maspeth, L. I.	J. H. Ives, Danbury.	45.00	
			A. S. Russell & Co., Meriden.	38.00	

* Bought at special rate.

SPECIAL MANURES, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's statement of average cash price per ton.
2307	Complete Manure for Corn and Grain.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	A. Williams, Collinsville.	40.00	$40.00
			W. F. Andross, E. Hartford.	42.00	
2264	Potato Manure.	Mapes' Formula and Peruvian Guano Co., New York.	David Beers, Danbury.	45.00	43.00
			Mapes Branch, Hartford.	43.00	
			Quinnebaug Store, Danielsonville.	46.00	
			D. B. Wilson & Co., Waterbury.	45.00	
			Abbott & Co., Birmingham.	45.00	
			Birdsey & Foster, Meriden.	44.00	
			Dean & Horton, Stamford.	43.00	
2280	Corn Manure.	Mapes' Formula and Peruvian Guano Co., 158 Front St., N. Y.	W. R. Foote, Branford.	42.–43.	41.00
			Dean & Horton. Stamford.	41.00	
			Mapes Branch, Hartford.	41.00	
			David Beers, Danbury.	43.00	
2295	Complete Potato Manure.	H. J. Baker & Bro., 215 Pearl St., New York.	W. W. Cooper, Suffield.	42.50	----
			Allen Betts, Norwalk.	42.00	
			Smith & Sons, West Cornwall.	42.50	
			D. N. Benton, Guilford.	39.00	
2306	Stockbridge Grass Top Dressing, and Forage Crop Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	M. H. Tanner & Co., Winsted.	41.00	----
			Dunham & Co., W. Cheshire.	43.00	
2283	Potato Phosphate.	Williams & Clark Co., Hanover Square, N. Y.	W. G. & F. Comstock, E. Hartford.	35.00	36.00
			F. C. Spaulding, So. Coventry.	34.00	
			J. H. Ray, Greenwich.	34.00	
			D. N. Benton, Guilford.	34.00	
			W. Kyle, Bethel.	40.00	
			C. H. Northrop, Ridgefield.	38.00	
			J. P. Kingsley & Sons, Plainfield.	35.00	
			E. M. Jennings, Southport.	35.00	
			L. F. Ellis, Woodmont.	33.00	

Special Manures, Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's statement of average cash price per ton.
2258	Stockbridge Corn and Grain Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	D. C. Wood, Stratford.	$42.00	$42.00
			M. H. Tanner & Co., Winsted.	41.00	
			W. H. Anderson, Putnam.	44.00	
			J. A. Lewis, Willimantic.	40.00	
			T. Pease & Sons Co., Windsor Locks.	42.00	
			F. Hallock & Co., Birmingham.	40.00	
			E. J. Dickerman, Mt. Carmel.	43.00	
			Dunham & Co., W. Cheshire.	45.00	
2206	Potato Manure.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Bought by Green's Farms Farmers' Club.	*	36.00
2250	Potato Manure.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Cochrane Bros., West Cornwall.	35.00	36.00
			E. C. Barnum, Naugatuck.	38.00	
			Mather & Grumman, Darien.	38.00	
			J. W. Beach, Stratford.	37.00	
			Waterbury & June, Greenwich.	38.00	
			W. F. Andross, E. Hartford.	38.00	
			M. Beach & Son, New Milford.	38.00	
			A. A. Hubbard, Canaan.	38.00	
			M. H. Tanner & Co., Winsted.	38.00	
			Raymond Bros., So. Norwalk.	37.00	
2247	Stockbridge Vegetable Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	W. F. Andross, E. Hartford.	42.00	
			J. M. Belden, New Britain.	41.00	
			Hubbell & Bradley, Saugatuck.	40.00	
			F. Hallock & Co., Birmingham.	40.00	
			T. Pease & Sons Co., Windsor Locks.	42.00	
			M. H. Tanner & Co., Winsted.	41.00	
			D. C. Wood, Stratford.	44.00	

* Bought at special rate.

Special Manures, Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Manufacturer's statement of average cash price per ton.
2282	Americus Brand Potato Fertilizer.	Williams & Clark Co., Hanover Square, N. Y.	W. G. & F. Comstock, E. Hartford.	$42.00	
			J. H. Ray, Greenwich.	38.00	
			E. M. Jennings, Southport.	42.00	
2305	Complete Manure for Corn.	H. J. Baker & Bro., 215 Pearl St., New York.	W. W. Cooper, Suffield.	42.50	----
2274	Potato, Hop, and Tobacco Phosphate.	Crocker Fertilizer and Chemical Works, Buffalo, N. Y.	H. A. Stillman & Co., Hartford.	35.00	$37.00–38.00
			Chandler & Morse, Putnam.	36.00	
			H. K. Brainard, Thompsonville.	36.00	
			E. Hill, Moosup.	----	
			W. Tillinghast, Plainfield.	37.00	
			J. M. Belden, New Britain.	37.00	
			L. D. Post, Andover.	35.00	
2354	Potato Fertilizer.	Preston Fertilizer Co., Green Point, L. I.	J. B. Merrow & Son, Merrow.	41.00	
2346	Potato Fertilizer.	E. Frank Coe, 16 Burling Slip, N. Y.	J. I. Worthington, Portland.	40.00	40.00
			W. C. Reynolds, East Haddam.	35.00	
			D. N. Benton, Guilford.	35.00	
2392	Davidge's Potato Manure.	Davidge Fertilizer Co., New York.	H. J. Stanclift, New Hartford.	38.00	
			Dunham & Co., West Cheshire.	42.00	
			G. W. Eaton, Plainville.	43.00	
			Young & Vaughn, Danielsonville.	43.00	
			Prentice & Young, Norwich.	42.00	
			E. E. Hill, Moosup.	----	

Analyses of Special Manures, Sampled by the Station.

Station No.	Name or Brand	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
2186	Rogers & Hubbard Co's Complete Potato and Tobacco Manure	2.76	....	3.09	5.85	*5.0*	....	8.47	5.24	13.71	*14.5*	8.47	....	11.47	*10.0*	....	$46.00	$49.61	*7.3
2187	Fairchild's Formula for Corn and General Crops	4.17	..	1.32	5.49	*5.5*	....	7.31	4.50	11.81	*12.0*	7.31	....	14.95	*12.0*	....	44.00	46.20	*4.7
2349	Cumberland Bone Co's Seeding Down Fertilizer	.35	.40	1.81	1.86	*1.7*	2.29	4.69	15.85	22.83	*18.0*	6.98	....	.27	*1.0*	....	30.00	30.98	*3.1
2315	Great Eastern Fertilizer Co's Vegetable, Vine and Tobacco Fertilizer	....	.18	2.61	2.79	*2.1*	5.12	6.44	2.67	14.23	....	11.56	*8.0*	5.60	*6.0*	5.71	34.50	33.45	3.10
2308	Bradley's Complete Manure for Top Dressing Grass and Grain	3.87	....	.34	4.21	*4.1*	7.21	1.80	1.08	10.09	*7.0*	9.01	*6.0*	5.81	*5.0*	5.52	35.00	33.33	5.0
2350	Mapes' Tobacco Manure	.82	4.27	1.93	7.02	*6.2*	1.96	2.79	.67	5.42	*4.5*	4.75	....	11.45	*10.5*	....	46.00	43.50	5.7
2351	Mapes' Fruit and Vine Manure	.39	.62	1.72	2.73	*1.7*	2.63	4.76	2.43	9.82	*7.0*	7.39	....	11.92	*11.0*	....	38.00	34.78	9.2
2268	Bradley's Complete Manure for Potatoes and Vegetables	.76	.84	2.46	4.06	*3.7*	7.25	3.41	1.15	11.81	*9.0*	10.66	*8.0*	6.00	*6.0*	4.60	40.00	36.00	11.1
2329	Quinnipiac Potato Manure	.66	.18	2.77	3.61	*3.3*	4.00	3.77	1.18	8.95	....	7.77	*5.0*	6.38	*6.0*	.72	35.00	31.44	11.3
2275	Mapes' Grass and Grain Top Dressing	.68	2.11	1.88	4.67	*4.1*	5.44	3.57	3.22	12.23	*7.0*	9.01	....	5.93	*5.0*	5.14	41.00	36.80	11.4
2205	Bradley's Complete Manure for Potatoes and Vegetables	.70	1.05	2.54	4.29	*3.7*	6.31	3.71	1.47	11.49	*9.0*	10.02	*8.0*	5.69	*6.0*	....	40.00	35.67	12.1
2328	Mapes' Tobacco Manure, Conn. Brand	....	.67	4.08	4.75	*4.7*	5.20	3.70	2.23	11.13	*7.8*	8.90	....	7.73	*7.7*	.87	44.00	39.24	12.1
2323	Lister's Potato Fertilizer	....	.20	1.68	1.88	*1.7*	7.71	5.33	.50	13.54	....	13.04	*8.0*	4.89	*4.0*	4.72	35.00	31.03	12.8

* Valuation exceeds cost.

ANALYSES OF SPECIAL MANURES, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found	Total Guaranteed.	Available. Found.	Available. Guaranteed	Found.	Guaranteed.				
2377	Acme Potato Fertilizer	....	1.92	1.08	3.00	*2.9*	4.36	3.33	2.29	9.98	*8.0*	7.69	....	9.08	*9.0*	1.90	$38.00	$32.99	15.2
2307	Bradley's Complete Manure for Corn and Grain	.46	1.05	2.21	3.72	*3.7*	9.69	.97	.39	11.05	*10.0*	10.66	*9.0*	5.61	*5.5*	4.75	40.00	34.39	16.3
2264	Mapes' Potato Manure	.78	1.51	1.71	4.00	*3.7*	4.82	4.09	3.91	12.82	*8.0*	8.91	....	6.78	*6.0*	.70	43.00	36.85	16.6
2280	Mapes' Corn Manure	.74	1.61	1.52	3.87	*3.7*	5.88	3.58	3.46	12.92	*10.0*	9.46	....	6.08	*6.0*	5.56	41.00	35.06	16.9
2295	Baker's Complete Potato Manure	....	3.01	.87	3.88	*3.3*	6.79	.14	.04	6.97	....	6.93	*5.8*	10.17	*10.0*	4.28	41.50	34.27	21.0
2306	Stockbridge Grass Dressing and Forage Crop Manure	3.49	....	2.32	5.81	*5.5*	6.48	1.18	2.00	9.66	*6.0*	7.66	*5.0*	2.98	*2.5*	2.33	42.00	34.70	21.0
2283	Williams & Clark Co's Potato Phosphate	....	1.10	1.61	2.71	*2.0*	7.00	.86	.36	8.22	*8.0*	7.86	....	6.47	*6.0*	.19	36.00	28.93	21.0
2258	Stockbridge Corn and Grain Manure	.39	.62	2.55	3.56	*3.3*	7.82	3.58	1.94	13.34	*7.0*	11.40	*6.0*	3.42	*4.0*	3.31	42.00	33.78	24.3
2206	Bradley's Potato Manure	.20	.11	2.44	2.75	*2.5*	7.53	1.73	1.36	10.62	*8.0*	9.26	*6.0*	5.12	*6.0*	4.45	36.00	28.90	24.6
2250	Bradley's Potato Manure	.24	.09	2.46	2.79	*2.5*	7.11	1.68	1.58	10.37	*8.0*	8 79	*6.0*	5.45	*6.0*	4.80	36.00	28.69	25.4
2247	Stockbridge Vegetable Manure	.69	.44	2.35	3.48	*3.3*	7.82	2.44	2.90	13.16	*9.0*	10.26	*7.0*	3.69	*5.0*	3.34	41.00	32.56	25.9
2282	Americus Brand Potato Fertilizer	....	1.76	1.80	3.56	*3.0*	5.69	1.22	.60	7.51	*7.0*	6.91	....	8.32	*8.0*	1.67	41.00	32.00	28.1
2305	Baker's Complete Manure for Corn	....	3.60	.90	4.50	*5.0*	6.36	.18	trace	6.54	....	6.54	*6.0*	7.94	*7.0*	7.81	42.50	32.76	29.7
2274	Crocker's Potato, Hop and Tobacco Phosphate	....	....	2.41	2.41	*2.0*	7.91	1.39	1.19	10.49	....	9.30	*8.0*	4.24	*3.5*	3.92	36.00	27.01	33.2
2254	Preston Fertilizer Co's Potato Fertilizer	....	.97	1.95	2.92	*3.3*	6.04	2.71	1.23	9.98	....	8.75	*8.0*	6.47	*7.0*	....	41.00	30.40	34.8
2246	Coe's Potato Fertilizer	....	.09	1.75	1.84	*2.1*	8.01	1.30	1.19	10.50	*10.0*	8.31	....	5.13	*9.0*	....	37.00	26.54	39.4
2292	Davidge Potato Manure	....	.24	2.94	3.18	*2.9*	7.58	.93	.12	8.63	*10.0*	8.51	*9.0*	4.48	*8.0*	4.06	41.00	27.95	46.7

III. Home-Mixed Fertilizers.

[For table of analyses, see page 77.]

Ten samples of these mixtures have been analyzed the past year. The formulas by which they were made are first given, followed by the table of analyses and certain conclusions drawn from it.

2262. A mixture made by a number of members of Advance Grange, Simsbury, from chemicals bought of L. Sanderson, New Haven. Sample drawn by J. C. Eddy, Secretary of the Grange.

100	pounds	of Nitrate of Soda @ $50. per ton cost	$ 2.50
100	"	Sulphate of Ammonia @ $70. per ton cost	3.50
640	"	Tankage (N. Y.) @ $35. per ton cost	11.20
700	"	Dissolved Bone Black @ $26. per ton cost	9.10
360	"	Double Sulphate of Potash and Magnesia @ $30. per ton cost	5.40
100	"	Muriate of Potash @ $41.50 per ton cost	2.07
2000	"	Mixture cost	$33.77
		Add freight to Simsbury	1.80
			$35.57

2245. Mixture for Potatoes, made by W. F. Andross, East Hartford.

400	pounds	of Sulphate of Potash.
400	"	Acid Phosphate.
400	"	Dissolved Bone Black.
600	"	Baker's Castor Pomace.
200	"	Dry Ground Fish.

This mixture has been used by Mr. Andross for four years and has proved very satisfactory.

2241. Mixture for Corn. Made by Dennis Fenn, Milford, from chemicals bought of C. Meyer, Jr., Maspeth, L. I. Sample drawn by Mr. Fenn.

300	pounds	Sulphate of Ammonia,	@	$71.60	per	ton cost	$10.74
1000	"	Bone	@	29.60	"	"	14.80
250	"	Tankage,	@	29.60	"	"	3.70
250	"	Dissolved Bone Black,	@	27.60	"	"	3.45
400	"	Muriate of Potash,	@	41.60	"	"	8.32
2200	"	of the mixture,	cost				$41.01

Or $37.38 per ton unmixed at Milford.

2231. Mixture for Potatoes. Made by Dennis Fenn from chemicals bought of C. Meyer, Jr. Sample drawn by Mr. Fenn.

200	pounds	Sulphate of Ammonia,	@	$71.60	per ton	cost	$ 7.16
1000	"	Bone,	@	29.60	"	"	14.80
250	"	Tankage,	@	29.60	"	"	3.70
250	"	Dissolved Bone Black,	@	27.60	"	"	3.45
275	"	Muriate of Potash,	@	41.60	"	"	5.72
275	"	High grade Sulphate of Potash,	@	61.60	"	"	8.47
2250	"	of the mixture,	cost				$43.30

Or $38.49 per ton unmixed at Milford.

2239. Mixture made by G. F. Platt, Milford, from chemicals bought of C. Meyer, Jr. Sample drawn by Station Agent.

1000	pounds	Sulphate of Ammonia,	@	$71.60	per ton	cost	$35.80
5000	"	Tankage,	@	29.60	"	"	74.00
5000	"	Dissolved Bone Black,	@	27.60	"	"	69.00
1500	"	Muriate of Potash,	@	41.60	"	"	31.20
1100	"	High Grade Sulphate of Potash,	@	61.60	"	"	33.88
4800	"	Bone,	@	29.60	"	"	71.04
18,400	"	of the mixture,	cost,				$314.92

Or $34.22 per ton unmixed at Milford.

2215. Home Mixture No. 1, made by C. T. Merwin & Son, Milford. From chemicals purchased of C. Meyer, Jr. Sample drawn by Mr. Merwin.

833 pounds Dissolved Bone Black.
667 pounds Tankage.
334 pounds Muriate of Potash.
166 pounds Sulphate of Ammonia.

2000 pounds of the mixture cost $33.41 unmixed.

2216. Home Mixture No. 2, like the above except that 170 pounds of bone were used, replacing the same weight of Tankage. Sample drawn by Mr. Merwin.

2219. Home Mixture No. 3, like No. 1 except that the tankage was from another manufacturer. Sample drawn by Mr. Merwin.

2218. Home Mixture No. 4. Made by Mr. Merwin.

260 pounds Tankage.
710 pounds Dissolved Bone Black.
330 pounds Muriate of Potash.
100 pounds Sulphate of Ammonia.
600 pounds Bone.

2000 pounds of the mixture cost $32.51.

2288. Mixture for Potatoes, made by Peck Brothers, Northfield.

600 pounds Dissolved Bone Black.
600 pounds Blood, Bone and Meat.
600 pounds Sulphate of Potash.
200 pounds Sulphate of Ammonia.
300 pounds Plaster.

2300 pounds of the mixture.

The chemicals used in the mixtures made in Simsbury and Milford were analyzed here and from the composition of the chemicals and the quantity used is calculated what the analysis would have been in each case if the weighings had been exact, the materials and mixture uniform and no loss or gain of moisture had happened in handling. This is entered in the table in the column headed "Calculated," p. 77. In general the agreement of the calculated and actual composition of the mixtures is fair, though there are some wide variations.

The prices given are regular retail quotations. In most cases the actual costs were considerably less on account of special rates obtained from the dealers.

Examination of the samples and of the table of analyses shows:

1st. That these home mixtures compare favorably in composition with the best commercial fertilizers. In all cases but one the valuation is higher than the average valuation of factory-made superphosphates or specials analyzed last year.

2d. The home-mixtures are not as finely ground as the *best* factory-made fertilizers, yet their mechanical condition is satisfactory.

3d. In only one case does cost of materials exceed valuation. If we add $3.00 per ton for cost of mixing, the valuation and the cost will be about the same. The cost of factory-made fertilizers usually exceeds valuation by 20–25 per cent.

These analyses justify the statement made in our last report that while it is often cheaper to buy the best commercial mixtures,—ammoniated superphosphates and special manures,—than to buy and mix the chemicals, yet the experience of a yearly increasing number of farmers shows that money may be saved by the seasonable purchase of raw materials and their use in home-mixtures.

We call the attention of those who intend to purchase raw materials the coming season and do their own mixing to the following suggestions:

1st. As has already been noted, soluble phosphoric acid should cost considerably less in the form of dissolved South Carolina rock than in dissolved bone black. Thus in New Jersey soluble phosphoric acid has cost about 6.2 cents per pound the present season in dissolved South Carolina Rock, while it has cost 7½ cents in dissolved bone black. The Carolina Rock yields a lower grade article than bone black, averaging in composition about as follows:

Dissolved South Carolina Rock.

Soluble phosphoric acid	9.9
Reverted phosphoric acid	1.7
Insoluble phosphoric acid	3.6
Total phosphoric acid	15.2

Besides superphosphates, there are other sources of phosphoric acid which are well worth the attention of buyers of raw materials. Thomas-Slag has been used with success abroad, and field experiments made for this Station in this State have in certain cases at least given very satisfactory results. [The outcome of this year's experiments will be found in the latter part of this report.] Fine ground bone containing from 24–30 per cent. of phosphoric acid from 1.5–4.0 per cent. of nitrogen can be got for from $26–32 per ton; while bone black superphosphate, containing 17 per cent. of phosphoric acid and a small fraction of 1 per cent. of nitrogen costs $26.

2d. This year the cheapest sources of organic nitrogen have been caster pomace at $20 per ton and cotton seed meal at $25. While Nitrogen in Blood, Tankage and Fish costs from 16 to 17 cents per pound, in Castor Pomace and Cotton Seed Meal it costs only 12 to 14 cents. Occasionally car lots of Cotton Seed Meal are offered at even lower rates because damaged and "off color." If the dark meal is not mouldy or damp its value *as a fertilizer* is probably not less than that of the prime quality meal. Of course it is unsafe to use as a *cattle food* any but the best quality of meal. There is good reason to believe that the nitrogen of these vegetable products is equally efficacious as plant food with that of animal matter and therefore it would be well to consider these materials in purchasing nitrogen. Their composition is given on page 35.

3d. There should always be a clear understanding between the purchasers and sellers of fertilizing chemicals as to their guaranteed quality. We reprint for the information of those interested a form taken with slight alterations from a circular sent to dealers in fertilizing chemicals by a New Jersey grange, which may be convenient for use by granges and farmers' clubs in this State:

"Wanted: to buy the materials to make —— tons *or more* of fertilizer. The materials to consist of nitrate of soda, sulphate of ammonia, acid phosphate, dissolved bone or bone black, fine ground bone, fine ground fish scrap, muriate of potash and sulphate of potash.

Home-Made Fertilizers, Analyses and Valuations.*

Station No.	Name.	Nitrogen.					Phosphoric Acid.					Potash.		Chlorine.	Valuation per Ton.	Cost of Chemicals [unmixed].
		As Nitrates.	As Ammonia.	Organic.	Total. Found.	Total. Calculated.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Calculated.	Found.	Calculated.			
2262	Advance Grange Mixture	.71	1.04	1.73	3.48	3.7	6.15	3.85	2.24	12.24	11.4	7.65	7.6	2.36	$36.20	$35.57
2245	W. F. Andross, Potato Mixture	....	....	2.85	2.85	2.7	5.54	1.47	1.21	8.22	7.4	4.92	4.5	.26	26.53	28.00
2241	Dennis Fenn, Corn Mixture	....	2.41	3.08	5.49	5.5	1.82	6.12	5.32	13.26	12.0	8.06	9.5	....	40.73	37.38
2231	Dennis Fenn, Potato Mixture	....	1.76	2.42	4.18	4.5	1.73	6.09	4.13	11.95	11.3	13.40	12.7	6.18	41.22	38.49
2239	G. F. Platt, Mixture	....	1.33	3.45	4.78	4.4	3.44	4.10	2.92	10.46	11.3	8.49	7.3	4.95	37.12	34.22
2215	C. T. Merwin & Son, Mixture No. 1	....	1.72	3.06	4.78	4.3	5.96	2.14	.88	8.98	9.0	9.00	9.2	8.24	37.04	33.41
2216	" " " 2	....	1.76	2.47	4.23	4.2	5.96	3.03	1.75	10.74	10.6	8.71	9.2	8.01	36.84	33.41
2219	" " " 3	....	1.76	2.94	4.70	4.6	6.39	1.51	.45	8.35	9.1	8.93	8.9	8.39	36.21	33.41
2218	" " " 4	....	1.03	2.51	3.54	3.5	5.58	5.33	2.44	13.35	13.6	8.58	8.8	7.93	37.55	32.51
2288	Peck Brothers, Potato Mixture	....	1.65	1.42	3.07	....	4.74	2.35	1.87	8.96	....	6.16	....	.56	29.27	....

* For description of samples, see page 73.

All materials to be in good mechanical condition; in good bags; to run even weights or be plainly marked what each bag contains *net*, and to be delivered at ——— early in March next. All materials to be guaranteed to contain certain percentages of nitrogen, potash, or available phosphoric acid, as the case may be; one-half of the bill to be paid within ten days after receipt of goods; on the other half a credit of sixty days to be allowed, within which time samples will be sent to the Connecticut Experiment Station for analysis, and if there found to contain as large percentages as guaranteed the balance of bill will be paid within the sixty days, but if any are found to contain a *less* percentage than guaranteed, then a discount is to be allowed on the bill equal to the loss in money value caused by such deficiency for the first one per cent. or fraction thereof, and *twice* the loss in money value for all deficiencies in excess of one per cent., and balance of bill within the sixty days. Samples to be taken by a station agent or other disinterested party."

Miscellaneous Fertilizers and Manures.

Cotton Hull Ashes.

2184. Sold by Charles L. Spencer, Suffield. Sampled and sent by C. M. Owen, Suffield.

2376. Sold by Charles L. Spencer, Suffield. Sampled and sent by Edmund Halladay, Suffield.

2198. Sold by J. E. Soper & Co., Boston. Sampled and sent by J. A. DuBon, Suffield.

2204. Sold by J. E. Soper & Co., Boston. Sampled and sent by H. W. Alford, Poquonock.

Analyses.

	2184	2376	2198	2204
Soluble phosphoric acid	.32	1.44	2.56	1.64
Reverted phosphoric acid	6.98	6.53	7.24	7.08
Insoluble phosphoric acid	.91	.46	.67	1.36
Potash	22.67	25.11	25.56	23.78
Cost per ton	$35.00	35.00	*	*
Valuation per ton	$36.28	39.90	43.35	39.94
Potash costs per pound†	5.2 cts.	4.5 cts.	....	....

* $30 in car lots.

† Reckoning soluble and reverted phosphoric acid as in mixed fertilizers and insoluble phosphoric acid at 2 cents per pound.

Hardwood, Unleached Canada Ashes.

2242. A sample sent by Austin Jennings, Green's Farms, from stock purchased of E. Jennings, Southport, contained 8.21 per cent. of potash and 1.96 per cent. of phosphoric acid. This is of excellent quality. It sold for 28 cents per bushel.

2393. Sent by T. A. Stanley, New Britain. Bought of Monroe, Judson & Stroup, Oswego, N. Y. Cost $14.00 per ton by the car load. The sample contained 1.43 per cent. of phosphoric acid, 5.69 per cent. of potash, and 17.12 per cent. of water. This sample is of about average quality.

Hardwood Ashes from a Brick-Kiln.

2391. Sent by T. A. Stanley, New Britain. Cost nothing but the cartage, which was about $2.50 per ton.

Analysis.

Phosphoric acid	1.87
Potash, soluble in water	1.94
Sand and earth	27.85

When such ashes cost no more than this lot they may be worth a trial. They contain twice as much potash as leached ashes and are much drier.

Tobacco Stems and Tobacco Dust.

2232. St. Louis Tobacco Stems. Stock bought by Comstock, Ferre & Co., Wethersfield.

2298. Tobacco Stems and Bone Black. From Olds & Whipple, Hartford. This is a fine powder, having bone black added probably to prevent its use in smoking tobacco or snuff.

2237. Tobacco Dust. Stock bought by Comstock, Ferre & Co., of A. D. Cowan & Co., New York.

Analyses.

	2232	2298	2237
Nitrogen	1.92	2.16	2.35
Phosphoric acid	.81	1.69	.61
Potash	8.71	7.84	2.59
Cost per ton	$11.00		30.00

The sample of Tobacco Stems is of average quality. The Tobacco Dust contains 25.7 per cent. of sand and is of less value as a fertilizer than Tobacco Stems, while the price is almost three times as great. It is used by the purchaser rather as an insecticide than as a fertilizer.

Hen Manure.

2252. Hen Manure. Sampled and sent by F. H. Stadtmueller from farm of Beach & Co., West Hartford. Cost $15.00 per ton delivered.

Analysis.

Water	51.84
Organic and volatile matter*	24.27
Ash†	23.89
	100.00
* Containing nitrogen as ammonia	.61
Organic nitrogen	.60
† Containing phosphoric acid	.97
Potash	.59

The phosphoric acid, potash and nitrogen contained in a ton of this "Hen Manure" could be bought in the form of chemical fertilizers for about $6.00. Numerous analyses have been made at this Station of "Hen Manure" but the material has always been a mixture of hen dung with variable quantities of feathers, straw and earth scraped from the floor of the hennery. We have no analyses of the unmixed hen dung. The difference between the excrement of fowls and that of cattle of all sorts is that the former contains in *solid form* all the fertilizing material of the food except what is retained in the body for growth or goes into the eggs; while a very considerable portion of the fertilizing value of the food of cattle is excreted in liquid form and is easily lost even in the stalls or barnyard. It is easy to see then why the "dung" of fowls is a richer manure than that of cattle. That of the former contains both the urinary and bowel excretions, that of the latter consists largely of the undigested food, with what of the urine may have been absorbed and retained by it.

Slaughter-House Refuse.

2396. Tankage which had been accumulating in a pit at a slaughter-house for some years. It had passed the first stages of putrefaction, was a wet, black, stinking mass, but contained no tough pieces of animal tissue or bone. Sent by C. E. Lyman, Middlefield. It contained about 72 per cent. of water.

Analysis.

Nitrogen as ammonia	.39
Organic nitrogen	.96
Phosphoric acid	.86

The "valuation," made as for a commercial fertilizer, is $5.74, but on account of its wetness it is doubtful if it would be really worth more than half that sum delivered on the farm.

Land Plaster or Gypsum.

2379. Nova Scotia Plaster. Stock of Nathan Couch, Branchville. Sampled and sent by D. H. VanHoosear, Wilton.

2380. From Smith & Sons, West Cornwall. Sampled by Station Agent.

2381. Nova Scotia Plaster. Stock of Cochrane Brothers, West Cornwall. Sampled by Station Agent.

Analyses.

	2379	2380	2381
Hydrated Sulphate of Lime	74.88	72.77	86.65
Matters insoluble in acid	1.28	7.44	2.93
Moisture	1.18	1.50	1.21
Other matters, chiefly Carbonate of Lime	22.66	18.29	9.11
	100.00	100.00	100.00
Cost per ton	$6.00	6.50	8.50

REVIEW OF THE FERTILIZER MARKET

For the Year ending November 1, 1888.

Nitrogen.

Nitric Nitrogen.

The *wholesale* price of nitric nitrogen in nitrate of soda was 12.7 cents per pound in November of last year. It rose to 13.8 cents in January, fell gradually to 12.8 cents in May, and rose again to 14.1 cents in October.

Its *retail* price in Connecticut this season has been a little under 16 cents ($50 to $52 per ton for nitrate of soda).

Ammonic Nitrogen.

The *wholesale* price for nitrogen in sulphate of ammonia was 14.7 cents per pound in November of last year. It rose to 14.9 cents in December and kept there pretty steadily till September, when it stood at 15.3 and rose in October to 15.8 cents.

Its *retail* price in Connecticut during the year has been from 17½ to 18 cents per pound.

Organic Nitrogen.

The nitrogen of high grade Dried Blood was quoted *at wholesale* in the New York market in November, 1887, at about 11.8 cents per pound. Since that time it has risen in price, as is shown in detail on page 87. The average cost in January was 12.2 cents, in March 13.9, and this figure held till June, when it began to rise again. The average quotation for October was 15 cents per pound.

The nitrogen in *Azotin* has ruled a trifle lower than in dried blood. The wholesale cost of nitrogen in these materials has been about twenty per cent. higher during the last three months of the year than during the first three.

Organic nitrogen *at retail* cost in this State last spring from 11.9 cents to 13.4 cents per pound in cotton seed meal and in two brands of castor pomace 13.9 and 14.4 cents. No stock of dried blood was found by our agents. In a single sample of dry ground fish nitrogen cost 18 cents.

Phosphatic Materials.

Refuse Bone Black at Wholesale fell from $17.75 in November of last year to $16.75 in March, where it remained till September, when it was quoted at $18.25 and in October at $19.20.

Rough and Ground Bone have been steady through the year at $18.00 and $22.50 respectively.

Ground Charleston Rock, f. o. b. N. Y., fell from $9.85 in November of last year to $9.25 in February, began rising in May, and in October stood at $10.25. The quotations for superphosphates have not fluctuated through the year. "Available" phosphoric acid in dissolved S. C. Rock has cost *at wholesale* in N. Y. 3.7 cents, in dissolved bone it has cost 4.05 cents.

Sulphuric Acid 66° B. ruled at 1.07½ cents per pound till September, when it rose to 1.10.

Potash.

In Muriate of Potash.

Potash in this form was quoted at *wholesale* in N. Y. at 3.46 cents per pound in November of last year. It stood at 3.48 in January and February, fell again in March and April to 3.46, rose again and stood at 3.50–3.52 till September, when it went up again to 3.71, where it now stands. It has *retailed* in Connecticut during the season at from 3.9 to 4.2 cents per pound ($41.50–$43.00 per ton of muriate of potash).

Double Sulphate of Potash and Magnesia.

Potash in this article shows frequent and considerable fluctuations. It has been quoted *at wholesale* in New York from 3.86–4.47 cents per pound. It has sold in this State at *retail* for about 5½ cents during the season.

High grade Sulphate of Potash.

This is a high grade sulphate (guaranteed 90–98 per cent. actual sulphate of potash) containing about as much potash, pound for pound, as muriate (50–51 per cent.). It is quoted in N. Y. *wholesale* for 2.3 cents per pound, or 4.5 cents for actual potash. It has cost a trifle over 6 cents at *retail* in Connecticut the past year.

Kainit.

Kainit has risen steadily from $8.00 per ton at the opening of the year to $10.00 in October. Assuming that kainit averages 12.4 per cent. of potash, the *wholesale* cost of potash in kainit in the N. Y. market has been from 3.2 to 4 cents per pound.

In general there has been a decided advance during the year in the prices of nitrogen in nitrates, ammonia salts and high grade organic matters.

There has been no very marked change in the quotations of dissolved phosphate, though the raw materials rule higher.

Potash salts are now considerably higher than in the early months of the year.

The market quotations given above are taken from the "Oil, Paint and Drug Reporter," published in New York. The weekly quotations for each month are averaged, and this average is taken as the quotation for the month.

The following explanations will be helpful in the examination of the market quotations, and will also serve to show the basis on which they have been interpreted in this review :

Phosphate rock, kainit, bone, fish-scrap, tankage, and some other articles are quoted and sold by the ton. The seller usually has an analysis of his stock and purchasers often control this by an analysis at the time of purchase.

Sulphate of ammonia, nitrate of soda and muriate of potash are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

Blood, azotin and ammonite are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the percentage of ammonia by 14 and divide that product by 17). A "unit of

ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain $8\frac{1}{2}$ units of ammonia, and if it is quoted at $2.25 per unit, a ton of it will cost $8\frac{1}{2} \times 2.25 = \$19.13$.

The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given.

Ammonia at	$3.00	per unit	is equivalent to	nitrogen at	18.2	cts. per lb.
"	2.90	"	"	"	17.6	"
"	2.80	"	"	"	17.0	"
"	2.70	"	"	"	16.4	"
"	2.60	"	"	"	15.8	"
"	2.50	"	"	"	15.2	"
"	2.40	"	"	"	14.6	"
"	2.30	"	"	"	14.0	"
"	2.20	"	"	"	13.4	"
"	2.10	"	"	"	12.8	"
"	2.00	"	"	"	12.2	"
"	1.90	"	"	"	11.6	"
"	1.80	"	"	"	11.0	"

Commercial Sulphate of Ammonia contains on the average 20.5 per cent. of nitrogen, though it is found to vary considerably in quality. When it has that amount of nitrogen (equivalent to 24.3 per cent. of ammonia),

At 4	cents	per lb.	Nitrogen costs	19.5	cents per lb.
" $3\frac{7}{8}$	"	"	"	18.9	"
" $3\frac{3}{4}$	"	"	"	18.3	"
" $3\frac{5}{8}$	"	"	"	17.6	"
" $3\frac{1}{2}$	"	"	"	17.0	"
" $3\frac{3}{8}$	"	"	"	16.4	"
" $3\frac{1}{4}$	"	"	"	15.8	"
" $3\frac{1}{8}$	"	"	"	15.2	"
" 3	"	"	"	14.6	"
" $2\frac{7}{8}$	"	"	"	14.0	"
" $2\frac{3}{4}$	"	"	"	13.4	"

Commercial Nitrate of Soda averages 95 per cent. of the pure salt or 15.6 per cent. of nitrogen.

If quoted at	3	cents per lb.	Nitrogen costs	19.2	cents per lb.
"	2⅞	"	" "	18.3	"
"	2¾	"	" "	17.6	"
"	2⅝	"	" "	16.9	"
"	2½	"	" "	16.0	"
"	2⅜	"	" "	15.2	"
"	2¼	"	" "	14.4	"
"	2⅛	"	" "	13.6	"
"	2	"	" "	12.8	"
"	1⅞	"	" "	12.0	"
"	1¾	"	" "	11.2	"

Commercial Muriate of Potash usually has 80 per cent. of the pure salt, or 50½ per cent. of actual potash.

If quoted at	2.00	cents per lb.	Actual Potash costs	3.96	cents per lb.
"	1.95	"	" "	3.86	"
"	1.90	"	" "	3.76	"
"	1.85	"	" "	3.66	"
"	1.80	"	" "	3.56	"
"	1.75	"	" "	3.46	"
"	1.70	"	" "	3.36	"
"	1.65	"	" "	3.26	"
"	1.60	"	" "	3.16	"
"	1.55	"	" "	3.06	"
"	1.50	"	" "	2.96	"

The Double Sulphate of Potash and Magnesia usually has about 26½ per cent. of actual potash.

If quoted at	1.00	cent per lb.	Actual Potash costs	3.77	cents per lb.
"	1.05	"	" "	3.96	"
"	1.10	"	" "	4.15	"
"	1.15	"	" "	4.34	"
"	1.20	"	" "	4.53	"

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since April, 1885. The price given for each month is the average of the four weekly quotations in that month. Sulphate of ammonia is assumed to contain 20.5 per cent. and nitrate of soda 15.6 per cent. nitrogen, and muriate of potash 50½ per cent. of actual potash or 80 per cent. of the pure salt.

		COST OF NITROGEN AT WHOLESALE IN				COST OF POTASH AT WHOLESALE IN	
		Blood. cts. per lb.	Azotin or Ammonite. cts. per lb.	Nitrate of Soda. cts. per lb.	Sulphate of Ammonia. cts. per lb.	Muriate of Potash. cts. per lb.	Double Manure Salt. cts. per lb.
1885.	April	13.6	13.7	13.2	15.2	3.51	---
	May	14.3	13.7	14.1	15.2	3.54	---
	June	13.9	13.7	14.0	15.2	3.36	---
	July	13.6	13.6	14.0	15.0	3.31	---
	August	13.8	13.6	15.0	14.9	3.34	---
	September	13.4	13.5	15.6	14.8	3.36	---
	October	13.4	13.5	16.0	14.8	3.36	---
	November	13.8	13.5	15.6	14.8	3.38	---
	December	14.1	13.9	16.0	14.9	3.39	---
1886.	January	14.0	14.2	15.6	15.1	3.38	---
	February	14.2	14.3	15.2	15.2	3.46	---
	March	14.9	14.7	16.0	15.8	3.64	---
	April	14.9	15.7	16.1	16.4	3.56	---
	May	14.6	15.4	16.4	15.8	3.41	---
	June	13.9	14.7	15.6	14.6	3.32	---
	July	14.2	14.4	14.9	14.6	3.31	---
	August	14.1	14.4	14.0	14.5	3.31	---
	September	14.1	14.4	13.7	14.4	3.40	---
	October	14.4	14.4	13.2	14.6	3.41	---
	November	14.0	14.4	12.7	14.7	3.41	---
	December	13.3	14.5	13.1	14.7	3.41	---
1887.	January	13.3	14.5	13.0	14.6	3.41	---
	February	13.5	14.5	13.6	14.6	3.41	---
	March	13.4	14.5	14.3	14.5	3.51	---
	April	13.6	14.1	14.9	14.5	3.56	---
	May	13.4	14.0	14.7	14.5	3.48	---
	June	13.1	14.0	14.0	14.5	3.41	---
	July	13.1	14.0	12.0	14.5	3.41	---
	August	12.6	13.4	11.8	14.5	3.40	---
	September	12.1	12.5	12.2	14.7	3.36	---
	October	12.1	12.3	13.0	14.9	3.36	---
	November	11.8	12.2	12.7	14.7	3.41	---
	December	12.1	12.3	13.8	14.9	3.46	4.08
1888.	January	12.2	12.3	13.8	14.9	3.48	4.24
	February	12.6	12.6	13.3	14.9	3.48	4.49
	March	13.9	13.6	13.1	14.9	3.46	4.15
	April	13.9	13.6	12.9	14.9	3.46	4.11
	May	13.9	13.6	12.8	15.2	3.52	4.24
	June	14.0	13.6	13.1	14.9	3.50	3.86
	July	14.2	13.9	13.1	14.9	3.50	3.86
	August	14.5	14.2	13.2	14.9	3.50	3.86
	September	14.6	14.2	13.9	15.3	3.71	4.38
	October	15.0	15.0	14.1	15.8	3.71	4.47

STATE OF CONNECTICUT.

ANNUAL REPORT

OF

The Connecticut Agricultural

EXPERIMENT STATION

For 1888.

PART II.

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REPORT OF THE DIRECTOR.

PART II.

[There remains a large amount of field and laboratory work the results of which it has been impossible to prepare for the printer in season for this Report.]

THE COMPOSITION OF AMERICAN FEEDING STUFFS.

By Dr. E. H. Jenkins.

On subsequent pages is given in tabular form the average composition of the feeding stuffs commonly used in this country, compiled exclusively from American analyses. In the first column of these tables is stated the total number of analyses from which the average was obtained. The probable accuracy of the average increases with the number of analyses on which it is based.

As it is very desirable to know within what limits the composition of each fodder is likely to vary, the maximum and minimum amounts of each ingredient have also been inserted in the table.

The wide differences of composition which appear in some cases are no doubt largely due to differences in the methods of analysis followed. It is extremely important that there should be uniformity in this respect and it is hoped that the methods recommended by the Association of Official Agricultural Chemists may be adopted by all who engage in agricultural chemical analysis.

Analyses of feeding stuffs made at this Station during the present year will be found further on in the Report.

Composition of American Feeding Stuffs.

Name.	Analyses.	Total Dry Matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free Extract.			Fiber.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	
Green Fodder.																	
Maize fodder	75	7.1	48.5	*21.26*	.5	3.0	*1.80*	.1	.9	*.45*	3.2	22.1	*12.94*	1.9	11.4	*4.99*	1.08
Maize fodder, ensilaged	59	13.0	35.6	*19.72*	.7	2.8	*1.52*	.2	1.8	*.70*	5.1	22.2	*10.49*	3.0	10.0	*5.70*	1.31
Sorghum	7	13.6	28.4	*21.66*	.9	1.4	*1.10*	.2	.5	*.31*	5.3	27.0	*13.08*	4.7	8.5	*6.25*	.87
Sorghum, ensilaged	5	22.0	28.1	*24.17*	.6	.9	*.75*	.1	.4	*.28*	13.8	19.0	*15.82*	5.9	6.8	*6.28*	1.04
Rye fodder	6	21.9	25.3	*24.72*	2.3	3.0	*2.61*	.2	.7	*.56*	4.9	12.4	*6.94*	4.9	14.9	*12.73*	1.88
Rye fodder, ensilaged	1	....	....	*19.25*	....	....	*2.42*	....	....	*.27*	....	....	*9.18*	....	....	*5.76*	1.62
Oat fodder	2	21.4	28.8	*25.10*	1.5	2.0	*1.77*	.4	.7	*.57*	10.8	14.6	*12.70*	7.1	9.5	*8.27*	1.79
Clover	1	....	....	*26.67*	....	....	*4.09*	....	....	*.69*	....	....	*11.61*	....	....	*8.12*	2.16
Clover, ensilaged	3	21.5	27.4	*23.73*	3.0	3.8	*3.34*	.9	1.1	*1.02*	8.1	11.4	*10.21*	5.1	8.6	*6.66*	2.50
Lucerne or Alfalfa	6	18.0	28.5	*22.83*	3.6	4.9	*4.09*	.7	1.0	*.83*	7.9	11.8	*9.60*	4.9	8.7	*6.26*	2.05
Serradella	3	15.4	19.9	*18.23*	2.3	2.7	*2.49*	.4	.4	*.41*	6.4	7.0	*6.80*	4.0	7.7	*6.42*	2.11
Cow-pea vines, green and succulent	5	13.9	27.2	*19.93*	1.7	3.3	*2.30*	.2	.6	*.43*	5.3	12.9	*9.27*	2.9	15.3	*6.31*	1.62
Beet leaves	1	....	....	*11.16*	....	....	*2.74*	....	....	*.60*	....	....	*2.49*	....	....	*2.50*	2.83
Carrot leaves	1	....	....	*16.70*	....	....	*4.26*	....	....	*.86*	....	....	*5.99*	....	....	*2.25*	3.34
Cabbage ensilage	1	....	....	*12.39*	....	....	*1.19*	....	....	*.93*	....	....	*4.52*	....	....	*1.59*	4.16
Hay and Dry Coarse Fodder.																	
Clover hay	33	78.2	93.9	*88.62*	8.9	20.8	*12.55*	1.5	4.3	*2.44*	35.0	49.0	*40.55*	15.6	35.7	*26.85*	6.23
Hay containing much clover	10	85.5	89.8	*86.68*	6.3	14.4	*10.33*	1.5	3.1	*2.52*	31.8	45.2	*40.46*	19.7	35.1	*28.07*	5.30
White clover hay	2	91.4	92.9	*92.12*	14.1	20.0	*17.03*	2.1	5.8	*3.95*	38.2	40.6	*39.38*	20.3	27.3	*23.75*	8.00
Alsike clover hay	5	91.4	94.7	*92.38*	11.4	16.1	*13.53*	1.6	4.2	*2.41*	36.5	43.5	*40.91*	24.0	29.5	*27.68*	7.85
Lucerne hay	4	91.6	94.3	*93.05*	10.2	18.6	*15.33*	1.4	2.4	*1.89*	35.4	47.3	*39.66*	26.2	33.0	*29.20*	6.97
Serradella hay	3	88.3	93.8	*90.80*	13.9	16.6	*15.24*	2.2	2.7	*2.74*	40.5	46.0	*43.95*	19.4	23.0	*21.64*	7.23
Timothy hay (*Phleum pratense*)	55	84.5	92.9	*89.79*	4.2	9.6	*6.15*	1.0	3.4	*2.12*	39.2	58.5	*46.98*	22.7	38.5	*30.35*	4.19
Red top hay (*Agrostis vulgaris*)	2	90.2	93.2	*91.68*	7.3	7.8	*7.50*	1.5	2.0	*1.70*	46.5	46.9	*46.72*	27.5	31.8	*29.62*	6.14
Timothy and Red top	10	85.7	91.8	*87.64*	4.8	9.0	*6.52*	1.5	2.7	*2.00*	38.5	48.9	*44.15*	24.7	38.4	*30.17*	4.80

COMPOSITION OF AMERICAN FEEDING STUFFS—*Continued.*

NAME.	Analyses.	Total Dry Matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free Extract.			Fiber.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	
HAY—*continued.*																	
Orchard grass hay (*Dactylis glomerata*)	5	88.2	93.5	*91.68*	3.6	8.2	*6.69*	1.4	2.4	*1.98*	33.5	48.6	*44.04*	29.7	38.3	*44.04*	5.72
Hungarian grass hay	13	91.0	95.2	*92.85*	5.0	12.3	*7.22*	1.5	3.5	*2.14*	44.4	53.0	*49.41*	23.6	31.3	*28.25*	5.83
Barley hay (seed in milk)	1	....	....	*89.75*	....	....	*9.21*	....	....	*2.47*	....	....	*47.49*	....	....	*26.14*	4.44
Oat hay	3	86.3	91.3	*89.32*	7.8	9.9	*8.53*	2.1	3.1	*2.52*	36.2	48.0	*41.93*	25.1	33.6	*29.92*	6.42
High meadow hay	2	88.7	89.4	*89.02*	6.8	8.3	*7.57*	2.0	2.5	*2.25*	46.9	47.5	*47.19*	24.3	25.2	*25.78*	6.23
Hay from mixed meadow grasses	11	79.7	87.0	*84.04*	4.8	9.2	*6.38*	1.4	2.7	*2.09*	34.4	47.3	*41.05*	22.9	35.9	*29.90*	4.62
Low meadow hay	10	85.5	93.6	*89.50*	4.6	10.4	*7.70*	.7	3.6	*2.20*	39.8	55.2	*43.60*	21.4	40.0	*30.20*	5.80
Hay from salt marsh grasses	13	81.4	92.8	*89.89*	4.0	7.8	*5.69*	1.6	3.1	*2.31*	34.1	54.3	*44.10*	25.1	37.9	*30.51*	7.28
Baled hay, "extra fine"	1	....	....	*84.05*	....	....	*6.20*	....	....	*2.19*	....	....	*45.13*	....	....	*26.60*	3.93
Maize fodder, field cured	7	60.6	77.1	*69.40*	3.8	6.8	*5.14*	.6	2.0	*1.40*	30.5	47.8	*39.08*	14.4	24.7	*19.61*	4.17
Maize stover, field cured	13	51.3	84.6	*75.56*	3.0	8.3	*5.29*	1.1	2.2	*1.48*	26.4	46.2	*40.09*	17.7	29.5	*24.17*	4.53
Buckwheat straw	3	89.6	91.0	*90.09*	3.3	7.8	*5.15*	.7	1.7	*1.26*	32.1	38.9	*35.16*	37.2	46.8	*42.98*	5.54
Oat straw	12	87.5	93.5	*91.26*	2.3	6.9	*3.82*	1.0	3.2	*2.22*	26.4	51.4	*38.89*	29.5	56.0	*41.52*	4.81
Rye straw	8	87.5	93.7	*92.24*	2.2	6.9	*3.46*	1.0	2.7	*1.40*	35.7	52.9	*38.35*	34.2	43.3	*45.25*	3.78
Wheat straw	6	82.1	93.5	*91.22*	2.9	5 0	*3.45*	.8	1.8	*1.29*	31.0	50.6	*37.33*	34.3	42.7	*44.99*	4.16
Cow-pea vines	6	86.0	90.7	*85.95*	13.6	19.8	*15.68*	1.1	4.1	*2.87*	34.9	46.4	*42.17*	17.2	23.7	*19.80*	8.41
ROOTS, BULBS, TUBERS AND OTHER VEGETABLES AND FRUIT.																	
Beets, red	5	10.5	14.5	*12.93*	1.1	1.7	*1.52*	.1	.2	*.16*	7.2	11.3	*9.20*	.6	1.7	*.92*	1.03
Beets, sugar	9	9.3	16.7	*13.44*	1.2	2.9	*1.92*	.05	.1	*.09*	7.0	13.6	*9.65*	.7	1.1	*.88*	.90
Mangolds	8	5.6	13.1	*9.60*	1.0	1.9	*1.44*	.03	.5	*.15*	2.4	9.6	*6.06*	.8	1.3	*.90*	1.05
Ruta bagas	3	11.6	13.0	*12.43*	1.2	1.3	*1.26*	.1	.3	*.17*	7.6	9.1	*8.50*	1.2	1.4	*1.30*	1.20
Turnips	3	7.6	12.8	*9.55*	.8	1.4	*1.14*	.1	.2	*.18*	4.2	8.8	*6.28*	.8	1.4	*1.15*	.80
Carrots	6	8.9	13.5	*11.70*	.9	2.0	*1.16*	.2	.7	*.42*	5.1	10.4	*7.68*	1.0	2.3	*1.38*	1.06
Onions	6	6.5	18.4	*12.45*	.8	2.3	*1.41*	.2	.4	*.26*	3.8	14.1	*9.53*	.6	.8	*.69*	.56

Composition of American Feeding Stuffs—*Continued.*

Name.	Analyses.	Total Dry Matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free Extract.			Fiber.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	
Roots, Bulbs, Etc.—*continued.*																	
Potatoes	7	19 4	24.1	*21.90*	1.1	3.0	*2.19*	....	.2	*.10*	15.3	20.0	*18.19*	.3	.9	*.54*	.88
Sweet potatoes	5	26.6	34.0	*29.37*	.5	3.6	*1.55*	.3	·6	*.38*	18.0	29.7	*25.09*	.6	2.5	*1.36*	.99
Cabbage	2	6.5	10.2	*8.28*	1.8	2.0	*1.95*	.2	·5	*.33*	2.0	3.5	*2.75*	1.4	3.0	*2.21*	1.04
Squash	2	4.8	5.4	*5.12*	.6	.6	*·66*	.2	·3	*.28*	2.9	3.5	*3.24*	.5	.5	*.54*	.40
Pumpkin	1	....	....	*7.73*	....	....	*1.11*	....	....	*.16*	....	....	*4.34*	....	....	*1.49*	.63
Apples	5	15.9	22.7	*18.22*	.2	1.2	*.69*	.3	.6	*.41*	12.6	20.0	*15.31*	.9	2.9	*1.49*	.32
Grains and other Seeds.																	
Barley	9	87.4	92.7	*89.08*	8.6	15.7	*12.39*	1.5	3.1	*1.86*	66.7	73.9	*69.88*	1.2	4.1	*2.57*	2.38
Buckwheat	8	85.1	89.1	*87.40*	8.6	11.1	*10.00*	2.2	2.4	*2.25*	62.6	65.4	*64.50*	7.8	9.4	*8.70*	2.00
Oats (raised in Conn.)	7	86.5	90.7	*89.06*	8.0	10.1	*9.32*	4.7	5.8	*5.29*	59.0	63.2	*61.55*	8.9	12.9	*9.95*	2.95
Oats	25	86.5	91.1	*89.06*	8.0	14.4	*11.38*	3.4	5.8	*4.81*	50.8	66.9	*60.05*	1.5	19.4	*9.85*	2.97
Rye	6	86.8	91.3	*88.40*	9.5	12.1	*10.60*	1.4	2.1	*1.70*	70.7	73.9	*72 60*	1.4	2.1	*1.60*	1.90
Wheat, winter	242	83.8	92.9	*89.48*	8.3	16.6	*11.73*	1.3	3.9	*2.11*	68.1	76.6	*72.01*	.4	2.9	*1.77*	1.86
" spring	13	86.6	91.9	*89.63*	8.1	15.4	*12.51*	1.8	2.5	*2.20*	66.1	78.6	*71.19*	1 3	2.3	*1.82*	1.91
" unclassified	55	87.6	90.9	*89.31*	9.8	14.7	*11.96*	1.6	2.8	*2.10*	68.5	74.7	*71.50*	1.2	3.1	*1.92*	1.83
" Average of all Analyses	310	83.8	92.9	*89.46*	8.1	16.6	*11.80*	1.3	3.9	*2.11*	66.1	73.6	*71.89*	.4	3.1	*1.80*	1.86
Maize, dent	80	85.9	93.7	*89.91*	7.5	12.1	*10.33*	3.8	6.9	*5.10*	66.2	75.7	*70.66*	1.2	4.8	*2.28*	1.54
" dent, raised in New England	12	84.8	91.2	*89.24*	8.3	11.6	*10.12*	3.8	5.1	*4.43*	66.6	74.2	*71.39*	1.3	2.4	*1.78*	1.52
" flint	71	80.4	93.4	*88.82*	7.0	13.7	*10.57*	3.4	7.1	*4.97*	65.0	74.6	*70.18*	.7	2.9	*1.64*	1.44
" flint, raised in New England	36	80.4	91.7	*87.77*	7.9	13.7	*10.91*	3.4	7.1	*4.91*	65.1	77.0	*69.16*	.8	2.5	*2.37*	1.42
" sweet	30	89.0	94.0	*91.04*	8.8	15.3	*11.33*	3.8	11.9	*7.68*	61.8	74.2	*67.48*	1.5	5.2	*2.69*	1.86
" "Western Corn"	3	79.3	83.6	*80.90*	7.8	8.6	*8.30*	3.6	3.9	*3.70*	64.9	68.2	*66.00*	1.7	1.8	*1.75*	1.20
" Average of all Analyses	184	79.3	94.0	*89.54*	7.0	15.3	*10.56*	3.4	11.9	*5.45*	61 8	77.0	*69.90*	.7	5.2	*2.09*	1.54
Sorghum Seed	9	83.2	90.7	*87.48*	7.6	11.2	*8.88*	2.1	4.6	*3.65*	68.6	73.6	*71.26*	1.4	3.2	*1.88*	1.80
Cotton Seed, hulls and kernels	1	....	....	*92.28*	....	....	*15.72*	....	....	*18.56*	....	....	*29.09*	....	....	*25.73*	3.16

COMPOSITION OF AMERICAN FEEDING STUFFS—*Continued.*

NAME.	Analyses.	Total Dry Matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free Extract.			Fiber.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	
GRAINS.—*continued.*																	
Flax Seed	1	....	....	*93.75*	....	....	*25.50*	....	....	*37.92*	....	....	*15.37*	....	....	*10.34*	4.63
Cow Pea	5	79.2	89.9	*85.21*	19.3	23.0	*20.77*	1.3	1.6	*1.43*	48.1	61.9	*55.75*	3.3	5.0	*4.06*	3.20
Bush beans	1	....	....	*85.00*	....	....	*20.37*	....	....	*1.62*	....	....	*56.71*	....	....	*3.20*	3.10
Soy Bean	4	86.9	93.9	*91.53*	34.6	40.2	*37.22*	12.3	19.0	*16.52*	26.2	30.5	*28.21*	3.7	5 0	*5.12*	4.46
FLOUR AND MEAL.																	
Barley Meal	3	83.8	86.0	*84.90*	8.8	13.9	*11.80*	.7	2.2	*1.70*	....	....	*70.90*	....	....	*.10*	.50
Buckwheat Flour	4	82.4	87.2	*85.46*	4.2	8.1	*6.89*	.7	1.8	*1.44*	71.1	79.4	*75.79*	.2	.5	*.34*	1.00
Oat Meal	6	91.1	93 8	*92.15*	12.9	16.2	*14.66*	6.1	8.8	*7.06*	66.6	68.9	*67.57*	.6	1.2	*.86*	2.00
Rye Flour	4	86.4	87.7	*86.90*	6.0	7.1	*6.65*	.8	.9	*.84*	77.6	79.1	*78.28*	.4	.5	*.41*	.72
Wheat Flour from winter wheat	1	....	....	*87.04*	....	....	*8.56*	....	....	*1.19*	....	....	*76.59*	....	....	*.17*	.53
" from spring wheat	6	86.5	89.7	*87.68*	8.6	14.1	*10.68*	.6	2.0	*1.11*	68.3	78.1	*75.00*	....	1.2	*.22*	.64
" Unclassified	21	86 4	88.8	*87.52*	9.7	13.3	*11.25*	.8	1.9	*1.16*	69.5	76.9	*74.33*	.1	1.0	*.25*	.53
" Average of all varieties	25	86.4	89.7	*87.44*	8.6	14.1	*11.28*	.6	2.0	*1.20*	68.3	78.1	*74.13*	.0	1.2	*.27*	.56
Graham Flour	3	86.3	87.9	*86.90*	11.3	12.4	*11.70*	1.5	1.9	*1.70*	69.8	70.0	*69.80*	1.8	2.1	*1.90*	1.80
Maize Meal	60	74.5	92.0	*84.40*	7.1	10.3	*9.15*	2.2	5.1	*3.84*	57.0	74.0	*67.96*	.5	3.1	*1.98*	14.5
Hominy	2	86.4	86.6	*86.50*	8.1	8.4	*8.25*	.4	.5	*.44*	77.1	77.2	*77.12*	.3	.3	*.32*	.38
Sorghum Meal, mostly decorticated	1	....	....	*86.84*	....	....	*8.25*	....	....	*3.85*	....	....	*71.27*	....	....	*1.88*	1.59
Pea Meal	2	87.0	91.2	*89.54*	19.1	21.4	*10.23*	.9	1.5	*1.19*	50.2	52.0	*51.09*	11.1	17.7	*14.33*	2.64
BY PRODUCTS AND REFUSE.																	
Apple Pomace	7	22.1	27.4	*22.94*	1.0	1.7	*1.40*	.6	2.0	*1.36*	12.6	17.6	*15.63*	2.0	5.9	*4.01*	.54
Brewers' Grains, wet from brewery	15	20.6	31.4	*24.99*	4.3	7.7	*5.57*	.8	2.9	*1.68*	10.1	15.7	*12.86*	3.0	5.6	*3.87*	1.01
" " "dried"	3	88.1	93.8	*91.81*	19 2	20.2	*19.89*	4.2	6.5	*5.56*	46.1	56.8	*51.75*	10.2	11.6	*11.01*	3.58
" " kiln-dried	1	....	....	*97.43*	....	....	*20.30*	....	....	*6.40*	....	....	*54.89*	....	....	*11.79*	3.97
" " from Silo	3	26.1	33.2	*30.18*	5.8	7.1	*6.64*	1.8	2.5	*2.11*	13.6	16.8	*15.53*	3 9	5.4	*4.64*	1.21

Composition of American Feeding Stuffs—*Continued.*

Name.	Analyses.	Total Dry Matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free Extract.			Fiber.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	
By Products and Refuse—*continued.*																	
Brewer's Swill	1	....	....	*5.70*	....	....	*1.90*	....	....	*.80*	....	....	*2.00*	....	....	*.70*	.30
Malt Sprouts	3	88.0	92.7	*89.72*	21.0	25.9	*22.95*	1.1	2.9	*1.79*	45.4	50.3	*48.60*	9.3	11.9	*10.72*	5.67
Cotton Seed Meal	29	81.5	94.2	*91.68*	23.3	50.8	*42.39*	10.2	18.0	*13.37*	12.7	38.6	*22.97*	2.7	11.7	*5.69*	7.26
Linseed Meal, Old Process	14	87.4	93.9	*90.79*	27.7	39.2	*32.26*	5.1	11.6	*8.35*	30.8	41.9	*35.26*	4.7	13.3	*9.13*	5.79
" New Process	12	86.6	93.2	*89.25*	27.1	37.1	*32.85*	1.3	4.4	*3.08*	35.2	48.0	*38.29*	7.6	14.0	*9.46*	5.57
" Oil not removed	1	....	....	*91.67*	....	....	*22.97*	....	....	*30.26*	....	....	*25.48*	....	....	*9.60*	3.36
Palm Nut Meal	3	89.1	93.8	*91.71*	13.5	16.0	*14.39*	6.4	18.7	*13.30*	33.8	41.6	*38.88*	18.7	23.9	*21.40*	3.74
Oat Feed	1	....	....	*91.81*	....	....	*12.64*	....	....	*6.14*	....	....	*56.31*	....	....	*12.48*	4.24
Rye Bran	6	86.3	91.8	*88.51*	11.5	16 8	*15.28*	1.8	4.9	*2.46*	59.8	67.6	*63.66*	2.5	4.1	*3.52*	3.59
Wheat Bran	68	84.2	91.8	*87.62*	7.5	17.5	*15.36*	1.5	5.9	*3.83*	50.0	67.6	*53.50*	2.4	17.8	*9.34*	5.59
" Middlings	27	84.0	91.5	*88.00*	10.1	19.2	*15.17*	1.3	12.7	*4.01*	53.0	70.9	*60.99*	2.1	5.9	*4.57*	3.26
" Shorts	8	84.5	89.0	*87.26*	11.1	16.1	*13.83*	2.5	5.3	*4.14*	53.3	67.0	*57.59*	5.8	10.5	*7.45*	4.25
"Hominy Chops," "Hominy Feed," "Baltimore Meal," "White Meal."	11	86.5	91.9	*88.86*	7.9	11.2	*9.85*	4.6	11.2	*8.43*	61.0	71.1	*64.49*	2.5	4.8	*3.59*	2.40
Gluten Meal	14	88.3	92.7	*90.72*	25.0	35.0	*29.73*	4.2	8.7	*6.58*	44.7	58.5	*52.08*	.7	3.8	*1.56*	.77
Maize Cob	17	75.2	92.8	*89.15*	1.2	3.7	*2.35*	.1	.9	*.45*	43.4	66.4	*54.65*	25.4	38.2	*30.36*	1.34
"Starch Feed," refuse from starch manufacture	9	27.8	42.9	*35.29*	3.6	9.6	*6.17*	1.3	4.4	*3.18*	18.7	28.9	*22.52*	1.6	4.3	*3.19*	.23
"Sugar Feed," kiln-dried, refuse from glucose manufacture	2	89.6	93.4	*91.50*	13.1	13.5	*13.30*	5.9	11.2	*8.60*	54.9	61.4	*58.10*	8.4	10.7	*9.50*	2.00
Sorghum Bagasse	4	11.3	16.6	*14.50*	.6	.7	*.65*		....	....	....	....	*10.20*	2.8	3.3	*3.10*	.60

CONNECTICUT GRASSES.

In the last Report the improvement of our meadows and pastures was spoken of as one great need of our agriculture. A better knowledge of our pasture and meadow grasses, their habits and uses, is a first step towards supplying this need. Questions as to the adaptation of different grasses to particular kinds of soil, the necessary water supply, their rooting habits, how they stand treading and close pasturing by cattle, causes of running out, etc., are still unsettled and show how much must be learned before we can manage grass land to the best advantage. Near our cities the hay crop is sometimes the most profitable one we have, and might often be made much more so by proper management. Our common grasses ought to be known, so that they can be readily told apart by farmers generally at all seasons of the year and rightly named, for till this is done it is clear that no one can speak or write about grasses with any chance of being understood. In the last Report were some explanations of the classification and naming of grasses and an explanatory list of the scientific and popular names of our commonest Connecticut grasses. There was also some account of the Station Forage Garden, in which are to be seen all our common grasses growing, correctly named, and where their habits can be studied to some extent and where pure seed can be got. Extra copies of this part of the Report can be supplied to any who want them.

During the present year there has been shown a greatly increased interest in this subject throughout the State. More than a hundred and fifty specimens have been sent in to be named or for other information from all parts of the State. Named specimens of fresh grasses have also been sent out by the Station in answer to requests for them. The Station is prepared to identify specimens of grass sent here, and so far as possible will supply collections of small samples of seed to any schools, granges, or farmers' clubs that would like to have a collection of named grasses growing near them.

Should sufficient interest be awakened, we could perhaps arrange to send by mail whole plants for inspection and study as they come into bloom through the season.

The Station is also always prepared to examine for farmers seeds of grasses or of vegetables with reference to their purity and vitality.

It is especially desired that any prevalent disease on grasses, such as mildew, rust, etc., and particularly ergot, which has sometimes done great injury at the west in wet seasons, may be brought to the attention of the Station.

Grasses in the Garden of the Station.

Considerable additions have been made to the garden, which now contains one hundred and fifty-seven species and varieties of grasses and forage plants.

The following list includes all grasses which have grown in the Station Forage Garden during the present season. The annual grasses of course, at this time, are dead, and have been sown again for next year. A dagger (†) before the name of a grass denotes that we have at our disposal, for exchange, a small quantity of its seed. The quantity which we propose to exchange will be quite small, in most cases only sufficient for a drill seven or eight feet long; enough, however, to show the characters of the grass, and to yield seed next year for a larger sowing, if that is desired. The seed we believe to be sound, strictly pure and true to name, most of it gathered in this garden and by our own hands.

†Agropyrum glaucum.
† repens. [*Triticum repens of Gray's Botany.*]
tenerum.
violaceum?
Agrostis canina?
† exarata.
† perennans.
† scabra.
† stolonifera?
† vulgaris, var. major.
† vulgaris, var. minor.
vulgaris, var. alba?
†Alopecurus agrestis.
geniculatus.
† pratensis.
Andropogon dissitiflorus. [*A. Virginicus of Gray's Botany.*]
macrourus.
† provincialis. [*A. furcatus of Gray's Botany.*]
scoparius.
Anthoxanthum odoratum. var. Puelii.
†Apera spica-venti.
Aristida gracilis.
purpurascens.
†Arrhenatherum avenaceum.
†Asprella hystrix. [*Gymnostichum hystrix of Gray's Botany.*]
Avena flavescens.
† sterilis.
†Boutiloua olygostachya.
Briza maxima.
†Bromus brizæformis.
ciliatus.
giganteus.
† inermis.
pinnatus.
† pratensis.
† Schræderi.
† secalinus.
segetum.
sylvaticus.
† tectorum.
†Cenchrus tribuloides.
Chloris submutica.
Chrysopogon nutans. [*Sorghum nutans of Gray's Botany.*]
†Cinna arundinacea.

Cynodon dactylon.
Cynosurus cristatus.
Dactylis glomerata.
†Danthonia spicata.
Deschampsia caespitosa.
flexuosa.
pulchella.
Deyeuxia Canadensis. [*Calamagrostis Canadensis of Gray's Botany.*]
Diplachne fascicularis. [*Leptochloa fascicularis of Gray's Botany.*]
Eatonia obtusata.
†Eleusine Coracana, var. stricta.
Indica.
Elymus Canadensis.
† Virginicus.
†Eragrostis capillaris.
† elegans.
pectinacea.
pilosa.
poeoides, var. megastachya.
Erianthus Ravennæ.
Eulalia Japonica.
var. variegata.
†Festuca duriuscula.
elatior.
† pratensis.
† heterophylla.
† nutans.
ovina.
† var. tenuifolia.
† var. rubra.
† pratensis.
† tenella.
Glyceria aquatica, var. Americana.
Canadensis.
† fluitans.
nervata.
Holcus lanatus.
mollis.
Hordeum jubatum.
Leersia oryzoides.
Virginicus.
†Lolium perenne.
var. Italicum.
var. tenue.
Melica cærulea.
ciliata.
Muhlenbergia capillaris.
† diffusa.
Mexicana.
Willdenovii.
Oryzopsis melanocarpa.
Panicum agrostoides.
† capillare.
† clandestinum.
crus-galli.
† var. hispidum.
dichotomum.
Germanicum.
glabrum.
latifolium.
† miliaceum.
sanguinale.
† virgatum.
Paspalum paniculatum.
† setaceum.
†Phalaris arundinacea.
cærulescens.
Canariensis.
Phleum pratense.
Phragmites communis.
Poa Abyssinica.
annua.
† arachnifera.
† compressa.
† nemoralis.
Nevadensis.
pratensis.
serotina.
sudetica.
† trivialis.
Reana luxurians.
†Setaria glauca.
verticillata.
† viridis.
Sorghum halapense.
vulgare.
Sporobolus depauperatus.
† heterolepis.
Stipa pennata.
† spartea.
Triodia seslerioides. [*Tricuspis seslerioides of Gray's Botany.*]
Vilfa vaginæflora.
† aspera.

OTHER FORAGE PLANTS IN THE GARDEN OF THE STATION.

Dolichos	Cow pea.
†Lathyrus sativus	Small pea.
Lotus corniculatus	Bird's-foot clover.
†Medicago turbinata	Snail Clover.
sativa	Alfalfa.
Melilotus albus	Bokhara Clover.
Ornithopus sativus	Seradella.
Onobrychis sativa	Esparsette.
Spergula maxima	Giant Spurrey.
Trifolium pratense	Red Clover, Bordeaux, Brittany, German, Hungarian, Mammoth, and Sapling varieties.
Alexandrinum	Egyptian Clover.
hybridum	Alsike Clover.
incarnatum	Crimson Clover.

We give below brief notes regarding some grasses grown in the garden which are not common in Connecticut, but which are valuable elsewhere and so receive very favorable notices from correspondents in our agricultural press and find a place in our seedsmen's catalogues.

Some of these grasses highly valued at the South and West are quite worthless here and some others having value are yet inferior to our common meadow grasses.

Texas Blue-Joint, Poa arachnifera. A year and a half ago both seed and roots were received from dealers at the south. The seed did not come up. The roots were very slow in starting but during the fall of 1887 and the present year have done well. This year the grass seeded. It spreads like June-grass by underground stems, but has not been as thrifty here, and the herbage is coarser.

Teosinte, Reana luxurians, here grows to a height of 4 or 5 feet, but does not blossom. The leaves are narrower, longer, and more tender than the leaves of maize. It makes scarcely any growth before the second week in July and the lightest frost kills it. We have little use for *teosinte* as long as we have maize, except possibly as a substitute for Hungarian grass.

Schräder's Brome-grass, or Rescue-grass, Bromus Schraederi or unioloides. Highly prized at the South and West. Does well on dry soils and is said to be very nutritious. Sowed in the fall of 1886 it completely winter-killed while the other Brome grasses were not injured. Sown in the spring it made good growth, pro-

ducing abundance of herbage and seeding freely. Here it is an annual, and can hardly be of any value as a farm crop.

Hungarian Brome-grass, Bromus inermis. This is one of the most promising new grasses in the garden. It produces an abundance of tender foliage, spreads quite rapidly by stolons, comes up quickly after cutting and last winter was perfectly hardy. It is said to grow on very dry soil. Hard frosts do not kill the foliage.

Meadow Brome-grass, Bromus pratensis, has made very satisfactory growth, its foliage is abundant and tender. It spreads much less rapidly than the last named grass and makes less fodder.

The Rye-grasses, Lolium perenne and Lolium Italicum. These were planted in September, 1886. They were perfectly hardy the first winter, grew luxuriantly the following summer, and seeded freely. But the following winter they died out largely or completely. The feeble growth of this year appears to be from seed dropped last season. These grasses are often used in lawn "Mixtures." They make a fine show the first season and then disappear. This may be an effect of competition with other grasses, but in our garden trials the Rye-grasses were protected from all interference of other plants. A grass which will make a great show the first season and then die out, should have no place in a mixture for permanent lawns.

Some *Sedges,* notably *Carex vulgaris,* have thrived in the comparatively dry soil of the garden.

The *Glycerias,* especially *Canadensis* and *aquatica,* have not grown satisfactorily in the garden. The *Leersias* just keep alive and *oryzoides* seeded this year. Another marsh grass, *Phalaris arundinacea,* or Red Canary Grass, has grown very vigorously. The Striped Grass of gardens is only a variety of this. On low swampy land this may be a very valuable grass. It is rather coarse but is relished by cattle, comes up quickly after cutting and is not killed down by frost. It is easily propagated from the stout under-ground stems. On cultivated land it might become a pest.

We have had difficulty in raising from seed the Conn. River bents;—blue bent, *Andropogon provincialis,* black bent, *Panicum virgatum* and Indian-grass, *Chrysopogon nutans.* These are

all very valuable native grasses, which deserve more attention than they receive; deep rooted and permanent, with proper treatment. We have ourselves collected the seed for two years when it was apparently ripe, but it has been slow in germinating and the catch was poor. Thus Panicum virgatum planted in Sept., 1887, came up in June, 1888, scattering. Blue-bent planted Sept., 1886, did not come up in the fall, and was replanted April 4, 1887. It came up June 1, scattering but strong and made a good growth that season without blossoming much. This year the stand is thicker by reason of shouldering from the parent stalks, the grass grew from 4½–5½ feet high and blossomed fully.

Observations on the Chemical Composition of Certain Grasses.

The garden now contains a number of our common meadow grasses growing each by itself in a small plot entirely clear of weeds and all other grasses. The crop from each of these plots is to be annually weighed and analyzed to determine whether under the same treatment, these grasses show decided and constant differences in composition and how great the variations in yield and composition may be from year to year. The results for the first year are here recorded. The soil of the garden is a light sandy loam, with gravelly subsoil overlying disintegrating red sandstone, which is from four to six feet below the surface. For four years before the plots were seeded the land had been fairly well manured with barn-yard manure, and planted to corn, with some ammoniated superphosphate in the hill.

On September 27, 1886, plots were staked off six feet by eight and seeded. During the season of 1887, the grass was not cut, but any bare spots were re-seeded and each plot was kept entirely free from all foreign plants. In the early spring of 1888, the dead grass was burned off and a fertilizer made up of 150 pounds of nitrate of soda, 250 pounds tankage, 30 pounds muriate of potash and 125 pounds dissolved bone black was sown over the whole garden, at the rate of 555 pounds to the acre.

The grass on each plot was cut but once and when not otherwise stated, at the time of full bloom. The crop after weighing was dried in the sun for several hours, then in a dry room for some days and afterwards was thoroughly dried in hot air and prepared for analysis. The results are given in the following tables, but discussion is reserved till further data are collected.

Analyses of Grasses.

Name of Grass.	Plot.	When cut.	Average height of flower stalks in inches.	Weight of crop in ounces.	Composition of the Crop.					
					Water.	Ash.	Albuminoids, etc.‡	Fiber.	Nitrogen-free extract.	Crude fat.
Tall Red-Top, Agrostis vulgaris, major	E	June 30		Fresh 542	76.15	1.66	1.97	7.96	11.65	.61
				Water-free 129		6.96	8.28	33.38	48.83	2.55
Fine Bent, Rhode Island Bent, Agrostis vulgaris, minor	D	" 30*		Fresh 270	71.56	1.93	2.77	9.34	13.64	.76
				Water-free 77		6.78	9.74	32.84	47.97	2.67
June-grass, Poa pratensis	A	" 11	30	Fresh 265	75.70	1.57	2.75	8.05	11.18	.75
				Water-free 64		6.50	11.30	23.11	46.10	3.07
Rough-stalked Meadow-grass, Poa trivialis	J	" 11	24	Fresh 165	72.79	1.73	2.67	8.24	13.74	.83
				Water-free 45		6.34	9.81	30.30	50.51	3.04
Wood Meadow Grass, Poa nemoralis	C	" 16	24	Fresh 177	64.33	1.91	3.66	12.04	16.98	1.08
				Water-free 63		5.36	10.27	33.75	47.60	3.02
Orchard-grass, Dactylis glomerata	I	" 11	41	Fresh 542	77.74	1.56	2.24	7.81	9.92	.73
				Water-free 120		6.96	10.07	35.12	44.62	3.23
Tall Oat-grass, Arrhenatherum avenaceum	Z	" 16	55	Fresh 306	73.46	1.56	2.11	9.24	12.97	.65
				Water-free 81		5.85	7.94	34.84	48.88	2.44
Yellow Oat-grass, Avena flavescens	Q	" 16	38	Fresh 209	66.70	1.38	2.55	11.39	16.72	.78
				Water-free 69		5.58	7.64	34.21	50.23	2.34
Meadow Fescue, Festuca pratensis	Y	" 20	39	Fresh 307	67.62	1.86	2.69	11 34	15.72	.77
				Water-free 99		5.74	8.30	35.02	48.57	2.37
Meadow Fescue, Festuca pratensis	G	" 20	39	Fresh 369	69.89	1.81	2.73	10.53	14.24	.80
				Water-free 111		6.04	9.06	34.96	47.29	2.65
Sweet Vernal grass, Anthoxanthum odoratum	S	" 11†	39	Fresh 125	75.13	1.46	2.89	7.73	11.95	.84
				Water-free 31		5.88	11.61	31.07	48.07	3.37

* Rather past full bloom.

† Past bloom, but cut at the same time with June-grass.

‡ Nitrogen × 6.25.

Name of Grass.		Per cent. Nitrogen.		Per cent. of Phosphoric Acid.	Per cent. of Potash.
		Total.	Albuminoid.*		
Coarse Red-top	Fresh	.32	.26	.11	.58
	Water-free	1.32	1.09	.47	2.43
Rhode Island Bent	Fresh	.44	.40	.17	.71
	Water-free	1.50	1.40	.56	2.49
June-grass	Fresh	.44	.38	.16	.72
	Water-free	1.80	1.56	.66	2.99
Rough-stalked Meadow-Grass	Fresh	.43	.39	.19	.85
	Water-free	1.57	1.45	.70	3.11
Poa nemoralis	Fresh	.59	.53	.18	.88
	Water-free	1.65	1.50	.50	2.48
Orchard grass	Fresh	.36	.31	.13	.83
	Water-free	1.61	1.38	.60	3.76
Tall Oat-grass	Fresh	.34	.30	.13	.84
	Water-free	1.27	1.11	.48	3.14
Yellow Oat-grass	Fresh	.41	.37	.18	.97
	Water-free	1.22	1.11	.58	2.91
Meadow Fescue (Y)	Fresh	.43	.36	.18	.89
	Water-free	1.32	1.11	.55	2.78
Meadow Fescue (G)	Fresh	.44	.40	.16	.84
	Water-free	1.45	1.32	.52	2.79
Sweet Vernal	Fresh	.46	.43	.16	.69
	Water-free	1.87	1.75	.66	2.80

* Determined by Stutzer's method described in the Station Report for 1885, p. 40.

Notes on Grass in answer to Correspondents.

The following abstracts from answers to letters of inquiry addressed to the Station, in regard to grasses have sufficient general interest to justify publishing them here:—

The grass sent is Annual Spear Grass, *Poa annua*. It blossoms earlier than any other grass in the spring, and may be found in blossom at almost any time in the year when it is not cold enough for heavy frosts. It makes a beautiful turf where it is not too shady, and where there is enough treading to keep other grasses from running it out. Nothing stands being trodden under foot so well. It is a rich nutritious grass, but the yield of course is very small. It seeds freely and perpetuates itself so, as well as by rooting from joints of the stem.

The grass betrays itself even before opening the package. It is Sweet Vernal, *Anthoxanthum odoratum.* Only one other Connecticut grass has this odor ; that is Holy Grass, *Hierochloa borealis,*—so called because it was considered sacred to the Virgin Mary—and that is very different in appearance.

You can pick out Sweet Vernal as soon as it greens in the spring. It grows in quite light green tufts, the leaves and stalks are short and stubbed like pin feathers, and when crushed give out this strong and agreeable odor. A little of it gives a mow of hay a sweet odor, but its green foliage is bitter and not relished by cattle. It is a perennial though an annual variety of it is sold here sometimes as "true perennial."

The annual is much smaller and comparatively worthless.

The specimen which you send is variously called "June-Grass," "Blue-Grass," or "Kentucky Blue-Grass," *Poa pratensis.* There is no botanical difference between our June-Grass or Blue-Grass, and the Kentucky Blue-Grass. In portions of Kentucky, June-Grass grows very lustily to the exclusion of most other forage grasses. This is the famous "blue-grass" region, but its product only differs from our June-Grass in its ranker growth. Many farmers use the name Blue-grass for *Poa compressa,* a very different thing, often called Wire-grass.

"Blue" is more applicable to *P. compressa* than *P. pratensis,* for the foliage of the former is a bluish green. This illustrates the confusion there is in the common names of grasses.

This Wire-grass is easily distinguished from June-grass by its color and its stalks which are flattened while those of June-grass are round.

You ask how to distinguish Blue or June-grass from Red-top. The leaf tips of June-grass are boat-shaped or awl-shaped, those of Red-top are flat and pointed. June-grass has very strong underground stems like Quack. Red-top has few or none. The stem of June-grass is less leafy than Red-top. It blossoms earlier. The seeds of June-grass are bunched, three to five of them together, and they are somewhat webby at the base. Those of Red-top are not bunched. Each is by itself and not webby.

June grass is not the best lawn grass. It is rather coarse and needs constant cutting. It does not make a good hay crop with us, for its foliage is at the bottom, the stalks are not leafy. It is best in pastures which are not too dry. It stands close feeding though not so close as Rhode Island Bent. When a pasture is overstocked, it will mostly disappear while the bent remains, but when the cattle are taken off it appears again.

The grass is Velvet-grass or Soft-grass, called in some parts of England "Yorkshire Mist," *Holcus lanatus*. It is not a native of this country. With us it is of very little or no value and is not worth a trial, I think, unless it covers ground where nothing else seems to do well. It has been raised at the south and is well spoken of in some quarters.

"What grass seed can I sow on rather wet land plowed occasionally to keep down bushes?"

You can probably get in Hartford or New York, seed of rough-stalked meadow-grass, *Poa trivialis*, and of "creeping bent." You might have success with them if the land is too wet for June grass. Nerved Meadow-grass, *Glyceria nervata*, would stand a good chance of staying on the land and doing well; so would Blue-joint, *Deyeuxia Canadensis*, but you cannot get the seed in market. An experiment in seeding with these would be very valuable. They are strong native grasses, inclined to be permanent; perhaps that is a reason why they are not popular in the seed trade!

This is Quack, *Agropyrum repens*, which varies so much in its appearance that it is not always recognized unless caught in its celebrated act of growing through a potato! It is a curse on cultivated land, but I have seen meadows full of it in this State which gave a heavy crop of excellent hay. It spreads rapidly, and puts up with almost any kind of soil. There is nothing better for covering unsightly *road or railroad* embankments to prevent washing.

WORK FOR THE STATE DAIRY COMMISSIONER.

The chemical work required by the Dairy Commissioner during the current year has been done at this Station and expert testimony furnished in court whenever necessary.

Examination of Butter.

On page 133 of our Report for 1886 the chemical methods of examination are given in detail. The method of determining volatile fatty acids has been somewhat modified in view of recent investigations made abroad.

The fat is saponified in a closed flask, with potassium hydrate solution (free from carbonates) without the addition of alcohol. Barium hydrate is used for the subsequent titration. Otherwise, the method now used by us is the same as there described.

Since that report, forty-five samples of suspected butter have been examined for the commissioner, of which thirty-five were imitation butter. The specific gravity of the imitation butter, determined as described in our report for 1886,—varied between .8583 and .862. The volatile fatty acids in 2.5 grams of filtered fat expressed in cubic centimeters of $\frac{1}{10}$ normal potassium hydrate solution varied between 0.5 and 6.4. A single sample of genuine butter had the exceptionally low specific gravity of .8625. The others varied between .8644 and .8666. The volatile acids varied between 12.82 and 16.81.

Examination of Molasses.

Fifty samples of molasses have been examined for the Dairy Commissioner. Of the first twenty-two samples collected by him after the passage of the law regarding the adulteration of molasses, nine were found to be mixed with glucose; one also contained salts of tin. After giving public notice that after a fixed date, all sellers of such molasses would be prosecuted, further samples were drawn and sent here for examination, but they all proved to be pure molasses. Apparently molasses mixed with glucose is no longer sold in the State.

Method of Examination of Molasses.

The method followed has been to polarize the molasses directly, after clearing with basic lead acetate, polarize after inversion according to Clerget's method at ordinary temperature, and polarize a third time at a temperature of about 88°.

No attempt has been made to calculate the sugar on account of the difficulty and uncertainty of the work, and also because it is not necessary to a correct judgment of the genuineness of the molasses. Genuine molasses will show from about 38 to 55 per cent. of "polarization sugar" by direct polarization, after inversion with an acid a polarization of from 10 to 18 or 20 scale degrees to the left in the Scheibler instrument at ordinary temperatures and from 0 to +5 or 6 degrees at 88° C.

Molasses adulterated with glucose almost always shows over 75 per cent. "polarization sugar" by direct polarization, which at once proves the adulteration, for molasses does not contain more than that quantity of solids altogether.

After inversion the rotation is still right-handed, though less than before. The rotatory power of dextrose ("glucose") is not changed by the acid used for inversion, dextrine and maltose (?) however, which are in the glucose syrup, have their right handed polarization somewhat lessened by the action of the acid and of course the cane sugar present is changed to invert sugar, which polarizes to the left. Nevertheless, the polarization of the whole mixture is still strongly to the right.

Next, when the temperature is raised to about 86° the polarization of molasses mixed with glucose syrup instead of sinking to within a few degrees of zero remains about where it was before, rising or falling slightly according to the relative amounts of dextrine and of invert sugar in it.

A glance at the following results will make these differences clear. The polarizations were made with Schmidt and Haensch's double compensation, half shade instrument. [26.048 grams sugar in 100 cc. 200^{mm} tube = 100 scale degrees]. The readings after inversion are corrected for dilution. In the table of analyses of pure molasses the samples marked with letters were kindly furnished by an importer as pure Cuba molasses. The lettered samples of adulterated molasses were also furnished by him but came from sellers of adulterated molasses. J is from a firm which it is said claims that the adulteration is so skillfully done under direction of their chemist that detection is impossible!

Genuine Molasses.

	"Polarization sugar."	After inversion, at ordinary temperatures.		Scale degrees at about 86° C.
D	+55.2	−12.6	at 27° C.	+2.2
E	55.2	13.0	27°	2.9
B	55.0	13.6	27°	1.8
F	53.2	12.3	27°	1.8
C	49.2	10.4	27°	4.4
A	49.0	13.4	27°	2.0
I	48.8	13.9	26°	.4
H	47.6	12.8	27°	.9
G	45.4	16.9	26½°	1.3
No. 3	45.8	12.1	22°	
" 4	48.6	13.2	23½°	
" 6	49.4	10.5	19½°	
" 7	48.4	——	——	
" 8	39.4	18.9	21°	2.4
" 14	47.6	14.7	18°	3.1
" 23	50.2	13.4	23°	
" 24	46.4	15.8	18½°	5.1
" 25	50.4	14.7	20°	4.6
" 26	48.0	16.7	22°	4.2
" 27	51.4	18.3	9°	4.6
" 28	42.9	17.8	23°	

Adulterated Molasses.

	"Polarization Sugar."	After inversion, at ordinary temperatures.		Scale degrees at about 86° C.
J	+107	+91.5	at 26°	+85.8
L	89	57.9	25°	59.4
K	45	−2.2	26°	11.0
No. 2	85.2	+58.1	16°	58.5
" 5	102.4	80.1	19°	78.5
" 9	47.8	5.0	14½°	18.9
" 10	118.0	95.0	14½°	94.2
" 11	106.0	77.9	14½°	78.3
" 12	101.0	70.6	14½°	70.2
" 13	87.2	59.0	17½°	62.4
" 19	90.4			
" 1	37.8	4.9	19°	6.2

The following table gives additional data for certain samples. In some of them the reducing action with copper solution was determined by Allihn's method * and the result was figured as dex-

* Jour. für Prak. Chem. **22**, 52. Fres. Zeits. für Anal. Chem. **22**, 448.

trose. [The reduction equivalent of invert sugar, however, is somewhat different from that of dextrose]. The sugar was then inverted and its reduction equivalent again determined and from the results of these two determinations cane sugar was reckoned. The results have value chiefly for comparison of these samples.

SUGAR BY ALLIHN'S METHOD.

	Dry Matter.	Sp. gr.	Cane Sugar.	Dextrose.
D	73.9			
B	72.8			
I	71.4			
H	75.8			
No. 3		1.368	45.09	18.50
" 4		1.375	45.61	19.34
" 7			44.39	16.30
J	76.9			
L	83.6			
K	77.9			
No. 2		1.385	18.01	34.12
" 5		1.385	11.05	36.08
" 1	75.7	1.383	32.93	26.11

EXAMINATION OF HONEY.

Several samples of genuine honey have been sent to the Station by H. L. Jeffreys, Esq., of New Preston, and J. R. Bostwick, Esq., of New Milford, for examination and comparison with "strained honey," found in market. The question was also asked whether the Station could detect adulterations of honey. Honey, like milk, butter, molasses and many other articles of food may be slightly adulterated in such a way as to escape detection. Generally, however, such slight adulteration is not financially successful. To make adulteration "pay" it must be so considerable that its detection by chemical examination is made almost certain. Only five brands of strained honey could be found in the New Haven market and all of these were largely adulterated with glucose. A single sample of honey in the comb was found to be perfectly pure as was to have been expected. The analytical data are here given though chiefly of interest to those who are called on to make examinations of this kind.

Methods of Examination.

Specific gravity.—Owing to the viscosity of honey, the method of Lenz was used. One part of honey and two of distilled water are accurately weighed and mixed and the specific gravity of the mixture is observed at 17° C. For this we have made use of the Westphal balance.

Copper-reducing power.—A solution of five grams of honey in water is made up to 500 cc. and in 25 cc. of the solution the reducing power determined by Allihn's method and expressed as dextrose. It is well understood that a considerable part of the sugar of honey is invert sugar which consists of equal parts of dextrose and lævulose which have towards Fehling's solution a somewhat different reducing power. But there is at present no satisfactory method of separately determining the two sugars, so the above purely arbitrary method of expressing the reducing power was adopted.

Copper-reducing power after inversion.—A solution of five grams of honey in water is made up to 200 cc., 20 cc. of pure concentrated hydrochloric acid are added and thoroughly mixed, and the whole is kept at a temperature of 68°–70° C. for 15 minutes. After cooling, the free acid is nearly neutralized with sodium hydrate, the solution is made up to 500 cc., and in 25 cc. the copper-reducing power is determined as above.

The difference between the copper reduced after inversion and that reduced before inversion is expressed as cane sugar.

Method of Polarization.—13.024 grams of honey (or one-half the normal quantity, for the polariscope used) are dissolved in water, 3 cc. of basic lead acetate are added, then 2 cc. of a saturated solution sodium carbonate and water to make exactly 100 cc.

The solution passed through a dry filter is examined in a 200^{mm} tube in the polariscope. The reading is multiplied by two to represent the polarization of the normal quantity of honey.

To 50 cc. of the above solution are added 5 cc. of pure concentrated hydrochloric acid, and the mixture is heated at 68°–70° in a corked flask for 15 minutes. After cooling, the temperature and the rotation in a 220^{mm} tube are observed, and the reading multiplied by two as before. The tube without being removed from the polariscope is now heated to about 86° C., and the rotation is again observed and corrected as before.

Ash.—Five grams of honey are dried and ignited at a low heat in a weighed platinum dish.

The following table, page 111, gives the results obtained on samples of pure and adulterated honey:

Dilution with water may be detected by the specific gravity. According to Lenz, no pure honey falls belows 1.111. The last five samples in the table, all of which are adulterated, have a somewhat lower specific gravity than the others, except comb-honey, No. 4, but none are below the limit named. Four of the spurious honeys have less copper-reducing power than the genuine samples but one, No. 10, has not.

The ash also gives no marked indication with regard to the nature of the honey. The polarization however, leaves not the slightest doubt in regard to the quality of the samples and in our opinion furnishes the only reliable means of detecting adulteration with glucose. All the samples here examined which were known to be genuine polarized to the left, and as a rule, genuine honeys are lævorotatory. Cases are on record of genuine honey with right-handed polarization. The hives were close to sugar refineries, and according to the theory of the observer, the bees had failed to completely invert the sugar gathered in the refineries. Such honey however, after inversion in the laboratory would have become lævorotatory.

All the genuine samples here examined, polarize further to the left after inversion than before, in consequence of the inversion of some cane sugar, which is almost always present in honey in small quantity. But the last five samples have a strong right-handed direct polarization, which could not be explained by the presence of cane sugar, for it remains only slightly reduced after inverting with an acid whereas cane sugar would have caused after inversion, a strong left-handed polarization. Therefore they contain some foreign substance, which polarizes strongly to the right, and is not greatly altered in its polarizing power by acids. This substance is undoubtedly glucose syrup.

A further confirmatory test was sought in the polarization of the samples after inversion at 86° C. At this temperature invert sugar becomes optically inactive and if honey consists, as it is stated generally to consist, of invert and cane sugar, it should not affect the polarized ray to any considerable extent at 86° C. But we have found a strong right-handed polarization in genuine honey on raising the temperature of the solution to 86°. This phenomenon, at present unexplained, will be further studied.

Honey Analyses.

	Sp. gr. at 17° C. 1 part honey, 2 parts water.	Copper-reducing power.		Polarization.					Ash.
		Direct calculated as Dextrose.	Inv'rt'd calculated as cane sugar.	Direct		After inversion.			
				Reading.	Temp.	Reading.	Temp.	At 86° C.	
From flowers and fruits, sent in the comb.	1.115	61.72	6.91	— 2.2	15°	— 4.2	17°	+ 18.7	.61
From basswood bloom, liquid, strained	1.115	67.00	3.04	— 7.0	17°	— 11.4	13°	+ 14.1	.40
Same as last, but granulated	1.114	66.64	3.61	— 6.4	20°	— 9.9	20°	+ 13.0	.51
Comb honey	1.113	67.30	1.77	— 8.8	15°	— 13.0	15°	+ 13.4	.38
Strained honey from the Station	1.114	67.40	2.20	— 6.4	20°	— 12.1	16°	+ 12.8	.40
Market Honey in the comb	1.1165	72.84	2.58	— 9.6	24°	— 18 0	18°	+ 9.0	.29
"Choice Clover Honey"	1.112	56.48	2.85	+ 61.4	23°	+ 55.0	20°	+ 51.7	.24
"Superior New Honey"	1.112	50.84	2.62	+ 72.0	24°	+ 64.4	18°	+ 68.6	.08
"Pure Northern Honey"	1.113	45 48	2.04	+112.8	22°	+110.2	14°	+103.4	.27
"Pure Orange Blossom Honey"	1.1125	65.44	1.56	+ 24 0	22°	+ 20.0	14°	+ 34.1	.18
"Pure Honey"	1.1117	53.52	.68	+122.6	26°	+122.1	17°	+113.3	.29

FIELD EXPERIMENTS WITH PHOSPHATES.

The cost of phosphoric acid in fertilizers varies greatly according to the material in which it is purchased. Thus in superphosphates prepared from bone black it costs at present about 8 cents a pound, in dissolved South Carolina Rock between 5 and 6 cents, in Bolivian Guano a little over 4 cents and in Grand Cayman's Phosphate and ground South Carolina Rock about 3 cents. Without doubt the more expensive superphosphates applied in moderate quantity will generally make a larger yield on land deficient in phosphoric acid, than the same quantity of the cheaper raw phosphates or natural phosphates as they are called. But since almost three times as much phosphoric acid can be bought for the same money in raw phosphates as in superphosphates it becomes a very practical question whether their prices stand in close relation to their agricultural value; whether for some crops instead of using a small quantity of superphosphate it may not pay to use a larger quantity of some other less soluble phosphate which costs less per pound. Last year a single experiment on this point was carried out with the assistance of Mr. W. I. Bartholomew of Putnam. The same experiment substantially has been repeated this year with the coöperation of the following gentlemen:

Mr. W. I. Bartholomew, Putnam.
Mr. W. H. Yeomans, Columbia.
Mr. W. R. Fish, Mystic Bridge.
Mr. C. A. Sill, Saybrook.
Mr. C. S. Andrews, Jr., New Britain.
Mr. E. A. Russell, Suffield.
Mr. Robert Aitken, Shaker Station.
Mr. G. F. Platt, Milford.
Mr. Edwin Hoyt, New Canaan.

The results are given in detail on the following pages. The general plan of experiment was as follows:

Land was in all cases selected which in the judgment of its owner was uniform in quality, which had all been cultivated alike and which had not been manured for some years. Only on such land could it be expected that one plot would give the same yield

as another plot similarly treated and that a fertilizer would considerably increase the yield.

Over the whole experimental field was broadcast a liberal quantity of nitrogenous matter and potash salts—more than sufficient for a maximum crop. This was essential in order that the yield should be limited by the quantity of phosphoric acid in the soil and not by either nitrogen or potash.

The field was then divided into 7 or more plots which were designated by letters A, B, C. etc., and on which the different phosphates were applied.

The phosphates chosen for comparison were: 1. Dissolved Bone Black, containing 16.53 per cent. of phosphoric acid; 2. A finely pulverized phosphatic rock, from Grand Cayman Island in the Caribbean Sea, containing considerable iron and alumina with 26.22 per cent. of phosphoric acid, placed at our disposal by N. B. Powter, Esq., 181 Pearl street, N. Y.; 3. Thomas-Slag, a bye-product of the steel manufacture, furnished by Paul Weidinger, Esq., No. 76 Pine street, N. Y., and containing 19.6 per cent. of phosphoric acid. 4. Ground South Carolina Rock, containing 25.5 per cent. of phosphoric acid. 5. Bolivian Guano. A phosphatic guano from the West Indies, furnished by the Quinnipiac Co. of New London, containing 17.2 per cent. of phosphoric acid. The analyses are given on pages 36 and 37 of this Report (Part I).

On the first plot a quantity of Dissolved Bone Black was used which it was believed would insure a fair yield and yet would not be in excess of the needs of a full crop but rather slightly deficient.

A single plot was given to each of the other phosphates and they were used in such quantity that the cost of each was just equal to the cost of the dissolved bone black on the first plot. Two or more plots received no phosphate and thus served to show the natural capacity of the soil itself to supply phosphoric acid to the crop.

The land was planted and cultivated as usual and the weight of the crop at harvest was taken in almost all cases by a representative of the Station. A fuller discussion of the reasons for the particulars of the experiment may be found in the last Report of this Station.

Experiments carried out by Mr. W. I. Bartholomew, Putnam.

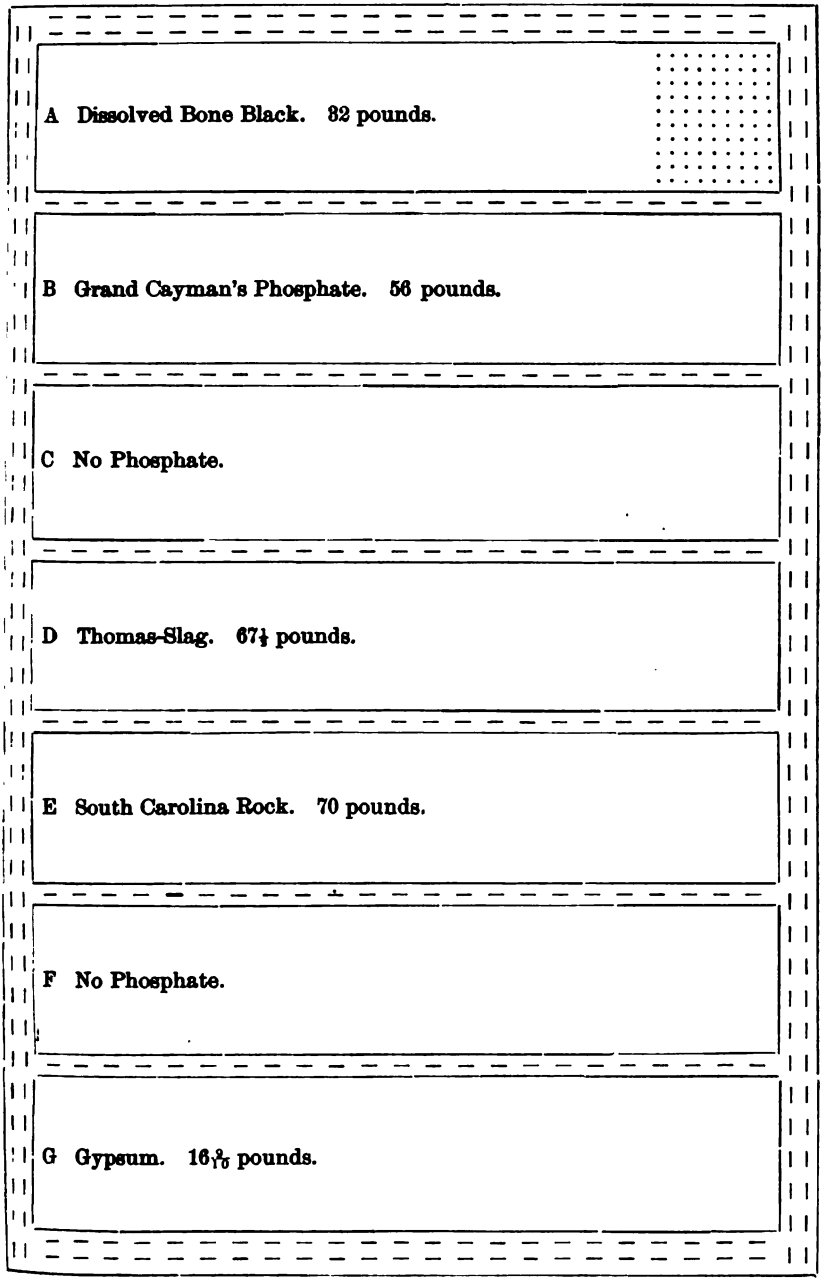
Experiment No. 1.—With Indian Corn.

The first experiment is a repetition of the trial made last year and described in our last Report, page 110. The land used for the experiment is high, gently sloping to the southwest. The soil is a dark loam, moist, with clayey sub-soil. In the fall of 1886 the land had been sown to rye, which was badly winter-killed. In 1887 it was used for an experiment like the present one. The details of that experiment are as follows. After plowing, 200 pounds of muriate of potash and 100 pounds of sulphate of ammonia were broadcast on the acre, the soil was well pulverized with a Thomas smoothing harrow and laid out in seven plots, each 10 rods long and 2 rods wide, containing one-eighth of an acre. On these plots a small variety of flint corn, Rhode Island White Cap, was planted in hills about 3 feet and 3 inches apart each way making 10 rows containing 500 hills in each plot. The phosphates were put in the hill. The general arrangement and the quantities of the phosphates used are shown in the diagram. The cost of the phosphatic material used on each plot was the same. At hoeing time the corn was thinned to five stalks to a hill. The year was uncommonly favorable for the corn crop. It was cut Sept. 20, and husked and weighed Oct. 14th. The yields will be spoken of presently.

This year the land was plowed again. 320 pounds of muriate of potash and 160 pounds of sulphate of ammonia were broadcast on the same field, but no phosphates were used. The same variety of maize was planted, the date and the method of planting and cultivation were precisely the same as last year. This experiment then should show whether the phosphates used last year and not then removed by the crop were still available for corn and how the different phosphates compared in this regard.

The crop grew without accident. A short but violent rain-fall on the evening of June 15 (nearly an inch of water fell in about half an hour) washed the surface somewhat, running off between the rows, but could not have very seriously interfered as the fertilizers had been pretty well worked in previously.

During the summer it was evident that the plot on which Thomas-Slag had been used the year before was doing best and the one which had Grand Cayman's stood next, both decidedly


A Dissolved Bone Black. 82 pounds.
B Grand Cayman's Phosphate. 56 pounds.
C No Phosphate.
D Thomas-Slag. 67½ pounds.
E South Carolina Rock. 70 pounds.
F No Phosphate.
G Gypsum. 16 3/10 pounds.

The plots are 2 rods wide and 10 rods long and contain one-eighth of an acre each. The hills of corn are one-fifth of a rod apart each way and the outside hills are one-tenth of a rod from the edge of the plot. Between the plots are spaces one-fifth of a rod wide and in the middle of each space is a single row of potatoes. The whole ground under experiment is surrounded by a double row of potatoes.

better than the Dissolved Bone Black plot. The month of August and the early part of September were cold, wet and quite unfavorable for the growth of the corn crop. On September 14 the corn was cut and shocked, having escaped the early frost and on October 22 it was harvested and weighed. It was still rather green for there had been much rain and little clear weather since cutting. The following table gives the results of the experiment and for comparison the results of the trial last year are included. It is to be remembered that *this year no phosphates were used* and the increased yields on plots A, B, D and E are due to phosphoric acid left in the soil from last year's experiment.

The yields this year on plots C and F that received no phosphate are nearly alike and show that the land was fairly uniform in quality.

If we call the average yield of the plots C and F, that had received no phosphate, 100 per cent., the yields of the other plots expressed in per cents, are as follows:—

	Season of 1887.			
	Sound ears.	Soft ears.	Stover.	Total crop.
No phosphate	100	100	100	100
A, Dissolved Bone Black	144	67	102	111
B, Grand Cayman's Phosphate	141	64	121	119
D, Thomas-Slag	140	57	107	110
E, South Carolina Rock	118	66	99	100

	Season of 1888.			
	Sound ears.	Soft ears.	Stover.	Total crop.
No phosphate	100	100	100	100
A, Dissolved Bone Black	111	77	112	106
B, Grand Cayman's Phosphate	137	73	125	121
D, Thomas-Slag	140	65	135	125
E, South Carolina Rock	127	80	118	115

Results.—1. In 1887, the year in which the phosphates were applied, equal money values of Dissolved Bone Black, Grand Cayman's Phosphate and Thomas-Slag had approximately equal effects on the yield of the corn crop. An equal money value of ground South Carolina Rock produced less than half as much increase of sound ears as the other phosphates without increasing the yield of stover. The season was very favorable for the corn crop particularly in August and early September. It was noticed that in the earlier stages of growth the plot which had dissolved Bone Black showed better development of the corn than the other plots but this difference disappeared before harvest.

Weights in Pounds of Field-cured Crops.

[Mr. Bartholomew's Experiment of 1888 with Indian Corn.]

Phosphates applied in 1887.	Sound Corn and Cob.		Soft Immature Corn and Cob.		Total Weight of Ears.		Stalks, Leaves and Husks.		Total Weight.	
	1887	1888	1887	1888	1887	1888	1887	1888	1887	1888
A, Dissolved Bone Black	479	345	108	108	587	453	472	434	1059	887
B, Grand Cayman's Phosphate	469	427	102	102	571	529	559	485	1130	1014
C, No Phosphate	319½	334	178	121	497½	455	465½	392	963	847
D, Thomas-Slag	463½	434	90½	91	554	525	494	526	1048	1051
E, South Carolina Rock	394	396	105½	112	499½	508	459½	459	959	967
F, No Phosphate	343½	289	140	159	483½	448	459½	386	943	834
G, Plaster	376	266	113	161	489	427	456	---	945	---

2. In 1888, no phosphates were applied. The plot which received Dissolved Bone Black the year before, produced only 11 per cent. more sound corn than the no-phosphate plots and only 6 per cent. more of total crop; while the plots which had Grand Cayman's Phosphate and Thomas-Slag produced nearly 40 per cent. more of sound ears and 25 per cent. more total crop than the no-phosphate plots and South Carolina rock 27 per cent. more of sound ears and 15 per cent. more of total crop.

An explanation of these facts may be found in the following statement which shows the quantity of phosphoric acid which was applied to the plots last year, the amount of phosphoric acid removed by the crop of last year and that of the present year, and besides the amount of phosphoric acid left in the soil. It will be seen that where dissolved bone black was applied last year there was not quite sufficient phosphoric acid left in the soil from this application to meet the requirements of the crop this year; therefore, it is not surprising that the yield this year on plot A is little larger than on the plot which had received no phosphate either last year or this.

	Phosphoric acid applied in 1887.	Phosphoric acid removed by crop in 1887.	1888.	Phosphoric acid remaining in the soil after the crop of 1888.
Plot A	40.6 lbs.	23.9	20.1	— 3.4
B	132.2	24.5	22.0	86.7
D	105.3	23.0	23.0	59.3
E	140.0	21.1	21.1	97.8

3. It will be seen that the effects of Grand Cayman's Phosphate and Thomas-Slag are as great this year as they were last year immediately after being applied. The percentage increase in crop in the case of Grand Cayman's Phosphate is exactly the same as last year, namely, 17 per cent., while the increase percentage of Thomas-Slag is a trifle larger, namely, 16 per cent. as against 13 per cent. last year. The Ground So. Carolina Rock made larger percentage increase this year than last, showing that it is slowly becoming available in the soil. These results need to be verified by other experiments on different soils but are instructive in themselves.

On this particular piece of land and in these two seasons Thomas-Slag and Grand Cayman's Phosphate have been more profitable than the Dissolved Bone Black.

Experiments Nos. 2 and 3.—With Potatoes.

Mr. Bartholomew carried out two other experiments of the same kind as the one described above, but with potatoes instead of corn. Both were in the same field with the first experiment. One was on land where rye grew in 1887, the other on land which was mowed in that year. In each there were seven plots, 5 rods long and 2 rods wide, making one-sixteenth of an acre in each plot. The spaces between the plots were the same as described on page 115.

Over each half acre were broadcast 240 pounds double sulphate of potash and magnesia and 80 pounds of sulphate of ammonia.

At planting the following quantities of phosphates were applied to the plots in *each* experiment.

A, 20 pounds Dissolved Bone Black.
B, 29 pounds Grand Cayman's Phosphate.
C, no phosphate.
D, 34.6 pounds Thomas-Slag.
E, 43.3 pounds ground South Carolina Rock.
F, no phosphate.
G, 34.7 pounds Bolivian Guano.

The following table gives the results of the experiments.

WEIGHT OF POTATOES IN MR. BARTHOLOMEW'S EXPERIMENT WITH PHOSPHATES.

	Experiment II. Planted after Rye.			Experiment III. Planted on Meadow Land.		
Phosphates applied.	Large.	Small.	Total.	Large.	Small.	Total.
A, Dissolved Bone Black	620	125	745	665	130	795
B, Grand Cayman's Phosphate	618	120	738	557	144	701
C, No Phosphate	475	120	595	550	88	638
D, Thomas-Slag	585	165	750	559	150	709
E, South Carolina Rock	462	130	592	570	120	690
F, No Phosphate	480	105	585	495	150	645
G, Bolivian Guano	540	136	676	491	105	596

The agreement between the plots C and F, which received no phosphate, in respect to yield is close enough to make it probable that the land was fairly uniform in quality.

If the average total yield of plots C and F is taken as 100 per cent., the comparative yield on the other plots is as follows:

	On Rye Land.	On Meadow Land.
C and F, No Phosphate	100	100
A, Dissolved Bone Black	126	124
B, Grand Cayman's Phosphate	125	109
D, Thomas-Slag	127	110
E, Ground South Carolina Rock	100	108
G, Bolivian Guano	114	93

Results.—The striking result of these experiments is that on the rye land both Grand Cayman's Phosphate and Thomas-Slag produced as large an increase over the no-phosphate plots as did Dissolved Bone Black. Bolivian Guano gave only half as much increase and Ground South Carolina Rock produced no increase at all.

But on inverted sod, while Dissolved Bone Black gave the same increase as on the rye land, Grand Cayman's Phosphate and Thomas-Slag gave very much less. South Carolina Rock gave as large an increase as these, while the Bolivian Guano yielded actually less than the plots to which no phosphate was applied.

Experiment No. 4.—With Indian Corn.

Mr. Bartholomew made for the Station a fourth experiment with the phosphates named, which was very nearly like the one made by him last year. An acre of land in the same field with the experiments just described was marked off to the north of and immediately adjoining the land on which the corn experiment was made last year and this. The plots were arranged and fertilized precisely as is described on page 115, except that Bolivian Guano was substituted for gypsum. The land had been in meadow, broken up last spring, and had received no manure for years. It was thought to be of uniform quality when planted, but great unevenness in the growth of the crop was noticed in the field as the season advanced. Many years ago—the precise number could not be determined—some manure heaps had stood on the west ends of the several plots and their effects could be plainly seen in the larger yields of sound ears and of stover on the west ends of the plots. The results of the experiment are given in the following table. In the columns headed E and W are given the weights of crop grown on the east and west ends of each plot.

Weights in Pounds of Field-Cured Crops.

[Mr. Bartholomew's Experiment No. 4 with Corn on Meadow Land.]

	Sound Ears.			Soft Ears.			Stalks, Leaves and Husks.			Total Weight of Crop.
	E.	W.	Total.	E.	W.	Total.	E.	W.	Total.	
A, Dissolved Bone Black	182	225	407	63	78	141	374	303	677	1225
B, Grand Cayman's Phosphate	164	204	368	56	47	103	232	262	494	965
C, No Phosphate	154	211	365	65	58	123	240	311	351	1039
D, Thomas-Slag	190	207	397	64	58	122	300	295	595	1114
E, South Carolina Rock	130	201	331	81	56	137	232	292	524	992
F, No Phosphate	74	112	186	80	82	162	173	191	364	712
G, Bolivian Guano	156	208	364	69	62	131	226	295	521	1016
	1050	1368		478	441		1777	1949		

It will be seen that on one of the no-phosphate plots the yield of sound ears was twice as large as on the other, and the yield of soft ears, and stover were also very different. The only conclusion justified by the results is that the land was not uniform in quality and not suited to the experiment.

This is the unsatisfactory issue of very many such experiments, an issue which cannot be foreseen or fully guarded against. The laying out of the land, the care of the crop and the weighing and recording of results were faultless.

Experiment carried out by Mr. W. H. Yeomans, Columbia.

The general arrangement of the experiment was the same as has already been described on pages 112 and 113. Muriate of potash was applied at the rate of 320 pounds and sulphate of ammonia at the rate of 200 pounds per acre. The separate plots contained each one-sixteenth of an acre. The quantities of phosphate applied are given in the following table,—the money value of the phosphate applied to each plot was the same.

Mr. Yeomans' notes supply all other details and are as follows:

"May 8th. Plowed the ground—a yellow, gravelly loam, with a clayey subsoil—that had been cropped with buckwheat the season before, being dressed with a superphosphate at the rate of 150 pounds per acre; previous to that had been in pasturage for a good number of years. At the time of plowing the soil was in good condition, but the next day it came on wet, continuing until the 10th, when after raining through the night the weather improved.

May 22d. The sulphate of ammonia and muriate of potash were sown on and harrowed in. The phosphates were put in the hill. Commenced planting the corn in the afternoon and finished on the 23d, with warm and pleasant weather and the ground in fine condition. From the 24th the weather continued cloudy and misty, with showers of rain until June 1st; with the exception of May 30th when there was some sun.

June 1st. The corn commenced to come up; that planted on the Thomas-Slag presenting the best appearance.

June 13th. Commenced hoeing the first time in the afternoon, finishing the forenoon of the 14th. At this time A and H pre-

sented an appearance of superiority, the other plots showing no distinctive difference.

June 21st. A and H making rapid growth with H leading. G but little better, if any, than C and F.

June 26th. Commenced hoeing the second time in the afternoon finishing in the forenoon of the 27th. A and H looking finely, showing less difference, while all the other plots continue backward.

During July the plots B, D, E and G showed quite a little improvement, and on August 1st, when A and H had commenced the development of ears, these exhibited no tendency to earing, but as the season advanced ear-formation commenced.

Sept. 19th. A and H well advanced in ripening. B appears quite fair in earing. D, E, G, have made some ears while C and F are very light. At the time of planting each plot consisted of five rows of fifty-five hills in each row, or two hundred and seventy-five hills in each plot; and to provide against loss from failure to germinate and from worms or usual depredations and have a stand of four stalks in each hill, six kernels were planted in each hill. It germinated unusually well, but cut worms made considerable havoc with it during the early growth. By the six kernels each plot should have had 1650 stalks, and allowing for a reduction of four in each hill upon an average, there should have been 1100 stalks.

The stalks in the several plots were counted carefully, giving the following result:

	Number of stalks.	More (+) or less (—) than a full stand.
A	991	—109
B	1073	— 27
C	919	—181
D	1122	+ 22
E	1008	— 92
F	985	—115
G	852	—248
H	979	—121

Sept. 25th. The corn was cut and placed in stacks, had not been affected by frost and was in good condition.

Nov. 15th. Corn husked and stalks weighed. The stalks on A and H were much the largest, those on H being larger than those on A, a feature which was marked during a considerable period of

the growth. On husking, the corn on A had more sound, smaller and compact ears than was the case with H, where the ears grew somewhat longer but only one upon a stalk, while many of the stalks of A had two ears each."

The results of the experiment are given in the following tables:

ACTUAL WEIGHTS OF CROPS AS HARVESTED.

(Mr. Yeomans' Experiment.)

	Stover.	Sound Ears.	Soft Ears.	Total Ears.
A, 16 pounds dissolved Bone Black	211	198	21½	219½
B, 23 pounds Grand Cayman's Phosphate	133	76½	54½	131
C, No Phosphate	78	2	34½	36½
D, 27½ pounds Thomas-Slag	118	34½	58	92½
E, 34½ pounds ground South Carolina Rock	106	18½	57	75½
F, No Phosphate	69	5½	32½	37½
G, 27½ pounds Bolivian Guano	102	23½	41	64½
H, 32 pounds dissolved Bone Black	293	179	31½	210½

These results have been re-calculated in the next table to a full stand of corn in this way. Plot A had 991 stalks on it which yielded 211 pounds of stover. A full stand would have been 1100 stalks. If 991 stalks yielded 211 pounds of stover, 1100 stalks would have yielded $\frac{211 \times 1100}{991} = 234.1$ pounds.

WEIGHTS OF CROPS, MAKING ALLOWANCE FOR MISSING STALKS.

(Mr. Yeomans' Experiment.)

	Stover.	Sound Ears.	Soft Ears.	Total Ears.	Total Crop.
A, Dissolved Bone Black	234.1	219.8	24.1	243.9	478.0
B, Grand Cayman's Phosphate	136.3	78.4	55.8	134.2	270.5
C, No Phosphate	93.3	2.4	41.3	43.7	137.0
D, Thomas-Slag	115.6	34.0	56.8	90.8	206.4
E, Ground South Carolina Rock	115.6	20.2	62.0	82.2	197.8
F, No Phosphate	76.9	5.9	36.5	42.4	119.3
G, Bolivian Guano	131.6	30.7	52.9	83.6	215.2
H, Double quality dissolved Bone Black	329.2	201.1	35.6	236.7	565.9

It appears in the first place that Mr. Yeomans' field was naturally poor in assimilable phosphoric acid and in this regard was suitable for the experiment. A moderate application of Dissolved Bone Black produced a three-fold increase of total crop and a five-fold increase of ears.

It also appears that the land was tolerably uniform in quality so that it is fair to assume that the differences in the yield of the plots were mainly due to differences in the effect of the phosphates, not largely to differences of soil.

Thus the two plots which received no phosphates produced 43.7 and 42.4 pounds of ears and 93.3 and 76.9 pounds of stover, respectively. Again the quantity of Dissolved Bone Black applied to A was not excessive, for while double the quantity, on plot H, gave 7 pounds less of ears it increased the yield of stover by 95 pounds. Mr. Yeomans' observation is noteworthy in this connection that the ears on A were rather smaller, but more compact and sounder than on H, where a double quantity of Dissolved Bone Black was used, and many stalks had two ears while on H there were no stalks with two ears.

If we call the average yield of the two plots which received no phosphate, C and F, one hundred per cent. then the yields on the plots will compare as follows:

	Ears.	Stover.	Total Crop.
C and F, No Phosphate	100	100	100
A, Dissolved Bone Black	567	275	373
B, Grand Cayman's Phosphate	312	160	211
D, Thomas-Slag	211	136	161
E, South Carolina Rock	191	136	155
G, Bolivian Guano	194	155	168
H, Double quantity Bone Black	550	387	442

Looking first at the yield of ears; where Dissolved Bone Black was used only a small portion of the ears were soft or immature, but everywhere else the proportion was large and except on B, Grand Cayman's Phosphate, much more than half. Dissolved Bone Black produced nearly three times the weight of sound ears that the Grand Cayman's Phosphate produced and about seven times as much as any other phosphate.

Of stover, Dissolved Bone Black yielded $1\frac{3}{4}$ times as much as Grand Cayman's Phosphate or Bolivian Guano and twice as much as Thomas-Slag or ground South Carolina Rock.

Results.—In general it may be fairly said that in this experiment, this year, Dissolved Bone Black yielded twice the return that an equal money value of any other phosphate yielded, that Grand Cayman's Phosphate came next, though greatly inferior in effect and that Bolivian Guano, Thomas-Slag and ground South Caro-

lina Rock did not differ greatly in crop-producing power and the plots which receive them gave about 1½ times as much crop as those which received no phosphates.

EXPERIMENT CARRIED OUT BY MR. W. R. FISH, MYSTIC, CONN.

The land for this experiment was high but moist and had been in grass and pasture for some years without top-dressing. It was laid off in plots each containing one-eighth of an acre. Between the plots a row of beans was planted as a marker.

The whole acre received 320 pounds of muriate of potash and 200 pounds of sulphate of ammonia, broadcast and harrowed in. The phosphates were also broadcast and harrowed in. The land was planted the last week in May. The crop was cultivated as usual and suffered no accident. When harvested, Nov. 5, it was very green and had moulded slightly on account of the weather which was everywhere extremely unfavorable.

The results are as follows:—

WEIGHTS OF CROPS AS HARVESTED.

(Experiment of Mr. Fish.)

	Sound Ears.	Soft Ears.	Stover.	Total Crop.
A, 32 pounds Dissolved Bone Black	437½	66½	473	977
B, 46.4 pounds Grand Cayman's Phosphate	455½	68	419	942½
C, No Phosphate	479	52	438	969
D, 55½ pounds Thomas-Slag	473½	73½	485	1032
E, 69½ pounds ground So. Carolina Rock	504	57	477	1038
F, No Phosphate	447	92½	475	1014½
G, 55½ pounds Bolivian Guano	431½	77½	464	973
H, 64 pounds Dissolved Bone Black	478½	54½	527	1060
I, About 7 cords stable manure per acre	384	73	392	849

The average yields on the two plots which received no phosphates and the percentage differences between the average and the yield of each plot are as follows:—

	Average yield.	Percentage difference.
Sound Ears	463	3.4
Stover	456½	4.0
Total crop	991½	2.3

The percentage increase, (+), or decrease, (−), on the several plots over the average of the no-phosphate plots is as follows:—

	Sound Ears.	Stover.	Total Crop.
A, Dissolved Bone Black	— 5.5	+ 3.6	— 1.5
B, Grand Cayman's Phosphate	— 1.6	— 8.2	— 5.0
D, Thomas-Slag	+ 2.2	+ 6.3	+ 4.0
E, Ground So. Carolina Rock	+ 8.8	+ 4.5	+ 4.6
G, Bolivian Guano	— 6.8	+ 1.6	— 1.9
H, Double quantity Dissolved Bone Black	+ 3.3	+15.5	+ 6.9
I, 7 cords stable manure to the acre	—17.1	—14.2	—14.4

Results.—Study of these results shows that the experiment, though carried out by Mr. Fish with all care and accuracy, throws no light on the question of the relative value of the phosphates. The reason is that the yield was not in any case strikingly increased by the application of phosphate so that probably the soil itself contained sufficient phosphate for the crop. In that case no difference could be looked for in the effects of the different phosphates.

EXPERIMENT CARRIED OUT BY MR. C. A. SILL, SAYBROOK.

Six years ago the land under experiment had potash salts and dissolved bone black and grew a good crop of corn. The following spring oats were sowed with a complete fertilizer. Since then the land has been in grass and has had no manure or fertilizer of any kind. It was plowed May 17 and the plots laid out, each containing one-tenth of an acre and running north and south.

On the south half of each plot muriate of potash was sowed at the rate of 160 pounds per acre and on the north half double sulphate of potash and magnesia at the rate of 320 pounds per acre. May 23d sulphate of ammonia was applied broadcast over all the plots at the rate of 200 pounds per acre and well harrowed with a wheel harrow.

The phosphates were broadcast on the several plots as indicated below and harrowed lengthwise.

May 24. Planted 296 hills of medium yellow flint corn on each plot. The seed was all shelled together and coated with coal tar.

June 2. Corn coming up. June 9, cultivated and hoed. June 20, cultivated. June 26, hoed and thinned to 3 plants in a hill. July 7, cultivated. July 30, hoed.

On the 22d and 23d of October the crop was harvested and weighed. The results follow:—

Weights in Pounds of Field-Cured Crops.

(Mr. Sill's Experiment.)

	Sound Ears. lbs.	Nubbins and Soft Corn. lbs.	Stover. lbs.	Total Crops. lbs.
A, 26 pounds Dissolved Bone Black	571½	33½	954½	1559
B, 37 pounds Grand Cayman's Phosphate	520½	37	789½	1347
C, No Phosphate	490¾	35	696	1221
D, 45 pounds Thomas-Slag	552	20	755	1327
E, 56 pounds S. Carolina Rock	580½	24¾	867¾	1473
F, No Phosphate	533½	37½	800	1371
G, 45 pounds Bolivian Guano	532½	29½	776½	1338
H, 26 pounds Dissolved Bone Black	515½	27	737¾	1280
I, 52 pounds Dissolved Bone Black	528¾	23¾	830½	1383

The yield of sound ears on the two plots which had no phosphate differed by 42¾ pounds or 8 per cent. of the average yield. Hence no effect on the yield of sound ears can be ascribed with certainty to a phosphate if the plot on which it was applied did not yield over 8 per cent. more than the plots which received no phosphate. The per cent. increase of yield of sound ears on the plots which had phosphate over the average yield of the plots which had none, is as follows:—

A, Dissolved Bone Black	11.5
B, Grand Cayman's Phosphate	1.6
D, Thomas-Slag	7.8
E, South Carolina Rock	13.3
G, Bolivian Guano	4.0
H, Dissolved Bone Black	.6
I, Double quality Dissolved Bone Black	3.0

It appears that an increase of more than 8 per cent. over the average yield on the plot which had no phosphate was obtained on only two plots A and E; that there was a difference of 11 per cent. in the yield of plots A and H which received the same quantity of Dissolved Bone Black. Moreover the yield of sound ears on one of the no-phosphate plots, F was greater than on any which received phosphates, except A and D.

Result.—These facts indicate that the land which appeared to be quite uniform in quality and which we had anticipated would be much benefited by phosphates was not uniform in quality nor deficient in assimilable phosphoric acid and for these reasons was unsuited for this special experiment. The experiment was

carried out by Mr. Sill with great exactness and was noted by an officer of the Station who examined it in the summer, as one of the most promising experiments of the series.

EXPERIMENT CARRIED OUT BY MR. E. A. RUSSELL, SUFFIELD.

The soil of the field used for this experiment was a rather light loam and had been in grass with no manure for a considerable number of years. The field sloped to the west and the plots and rows ran from east to west. Muriate of potash at the rate of 320 pounds and sulphate of ammonia at the rate of 200 pounds per acre were broadcast over the whole piece. Each plot contained one-tenth of an acre. The phosphates were used in the hill, "Angel-of-Midnight" corn was planted on the 21st and 22d of May, in hills 3½ feet apart each way, 4 stalks in a hill. Wire worms destroyed considerable of the corn before it came up and as the seed gave out, some Canada corn was used for planting over (on June 9) which matures a little earlier than the other. At the second hoeing a few hills had to be planted again. It was noticed August 1st when an officer of the Station examined the field that from plots A to G, the stand on the upper end of the plots was considerably lighter than on the lower end. The crop was cultivated in the usual way and the corn cut and stacked on the 18th and 19th of September. On Oct. 19th, the stacks were weighed ready for husking. Rain came on and the husking could not be finished and the ears weighed till the 25th. Following are the results:—

WEIGHTS OF FIELD-CURED CROPS.

(Mr. Russell's Experiment).

	Sound ears.	Soft ears.	Stover.	Total crop.
A, 26 pounds Dissolved Black	527½	9½	1037½	1575
B, 37 pounds Grand Caymen's Phosphate	477	12½	807½	1297
C, no phosphate	439	24½	828½	1292
D, 45 pounds Thomas-Slag	377	95½	754½	1227
E. 56 pounds Ground So. Carolina Rock	349	98½	728½	1176
F, no phosphate	345	108½	770½	1224
G, 45 pounds Bolivian Guano	415	78½	921½	1415
H, 52 pounds Dissolved Bone Black	450½	74	930½	1455
I, no phosphate	364½	68	798	1230½
J, 50 pounds Swift Sure Superphosphate	448½	52½	996	1497

The average weights of crops on the three plots which received no phosphates, and the largest percentage difference between this average and the yield on any single one of the three plots are as follows:—

	Average yield.	Percentage difference.
Sound ears	382.8	14.7
Stover	799	3.6
Total crop	1248⅛	3.5

Since the differences in the natural capacity of the soil of different plots are equivalent to 14.7 per cent. of the total yield of sound ears at least, it follows that unless an increase of yield of sound ears on a plot which received phosphate amounts to more than 15 per cent. of the average yield on the no-phosphate plots, the increase cannot fairly be attributed to anything other than the inequalities of the soil. For the same reason differences of 4 per cent. in the yield of stover or total crop are not significant.

The percentage increase (+), or decrease (−), of yield on the plots which received phosphate over the average of the unmanured plots is as follows:—

	Sound ears.	Stover.	Total crop.
A, Dissolved Bone Black	+37.7	+30.0	+26.1
B, Grand Cayman's Phosphate	+24.6	+ 1.0	+ 3.9
D, Thomas-Slag	− 1.5	− 5.7	− 1.8
E, South Carolina Rock	− 8.9	− 8.9	− 5.8
G, Bolivian Guano	+ 8.4	+15.4	+13.3
H, Double quantity Dissolved Bone Black	+17.7	+16.4	+16.5
J, Swift Sure Superphosphate	+17.2	+25.0	+20.0

Result.—It appears that Thomas-Slag and South Carolina Rock had no effect on the yield, and that Bolivian Guano had only very little, if any effect. Dissolved Bone Black increased the yield both of sound ears and stover noticeably, and Grand Cayman's Phosphate increased the yield of sound ears, but not of stover or of total crop.

Experiment Carried Out by Mr. C. S. Andrews, Jr., New Britain.

The soil of the experiment field was a light sandy loam. It had not been manured for 10 years, had been in grass for some years and was believed to be in an exhausted condition. It would not yield half a ton of hay to the acre. The plots each

contained one-eighth of an acre (2 rods wide and 10 rods long) and were separated by a strip of turf 3 feet wide. The plots and rows ran north and south. On the acre and one-eighth were broadcast 320 pounds of muriate of potash and 200 pounds of sulphate of ammonia. The phosphates were put in the hill. The corn was a variety called Top-over. The rows were about 3½ feet apart, hills 3½ feet in the row. Five kernels were planted in a hill and thinned to 4. The blackbirds pulled a very little of it, necessitating some replanting.

The planting was done May 21. The crop was carefully cultivated, cut and stacked without suffering from frost, husked Oct. 16th, and weighed shortly after. Severe and frequent rains made it difficult to weigh the stover when it was in good condition.

Following are the results:

Weights of Field-cured Crops.

(Mr. Andrews' Experiment.)

	Sound Ears.	Soft Ears.	Stover.	Total Crop.
A, 32 pounds dissolved Bone Black	372⅝	69½	704	1146½
B, 46 pounds Grand Cayman's Phosphate	338½	58	641	1037½
C, No Phosphate	337	64½	628	1019½
D, 56 pounds Thomas-Slag	334	62	707	1103
E, 69 pounds So. Carolina Rock	275	81⅛	550	906⅛
F, No Phosphate	259½	70½	497	827
G, 55 pounds Bolivian Guano	309	68	602	979
H, No Phosphate	320½	60½	614	995
I, 64 pounds dissolved Bone Black	278	58½	629	965½

The average weights of crop on the three plots which received no phosphates and the largest percentage difference between the *average* yield and that of any one plot are as follows:

	Average yield.	Percentage difference.
Sound Ears	306	15.2
Stover	579	14.2
Total Crop	947	12.7

The percentage increase, or decrease, (—), of yield on the several plots calling the average yield on the unmanured plots 100 per cent. is as follows:

	Sound Ears.	Stover.	Total Crop.
A, Dissolved Bone Black	21.8	21.6	21.0
B, Grand Cayman's Phosphate	10.6	10.8	9.5
D, Thomas-Slag	9.1	22.1	16.5
E, South Carolina Rock	—10.0	— 5.0	— 4.3
G, Bolivian Guano	.9	3.9	3.4
I, Double quantity Dissolved Bone Black	9.2	8.6	2.0

Result.—It appears that in this experiment there was only a single plot [A, Dissolved Bone Black], where the increase of crop over the average of the no-phosphate plots was decidedly larger than the variation of the no-phosphate plots among themselves. The land, therefore, was not uniform in character and not strikingly deficient in assimilable phosphoric acid; for these reasons alone the results do not help to solve the special point under experiment, viz: the relative value of the phosphates named.

Experiment carried out by Mr. Robert Aitken, Shaker Station.

The soil of the experiment field was a light, sandy loam. It had not been cropped or manured for four years. Over an acre of the field, after plowing, were broadcast 320 pounds of muriate of potash and 200 pounds of sulphate of ammonia. Nine plots were laid off, each containing one-tenth of an acre, with a four foot space between the plots. On these plots the phosphates named below were broadcast with great care. The seed was "Brainard Corn," a flint variety. The hills stood 3¾ feet apart each way, with four stalks to a hill. The piece was planted May 25th, and cultivated as usual. When visited in August by an officer of the Station no missing hills were found, but all through the piece were spots where the corn was weak and poor. The plots ran from east to west and the east side of each plot seemed to have the heaviest stand. No reason could be given for these defects, as there was every reason to believe that the whole piece was uniform in quality.

The corn was cut about the 15th of September. It was husked and harvested Oct. 16. The weather was extremely unfavorable, as there was rain almost every day for two weeks. The crops on plots A to F inclusive were weighed that day, but continuous rain prevented harvesting the others till the 22d. This in itself made the experiment less satisfactory. Following are the results:

Weights in Pounds of Field-Cured Crops.

(Mr. Aitken's Experiment.)

Phosphates Applied.	Sound Ears. lbs.	Stover. lbs.	Total Crop. lbs.
A, 26 pounds Dissolved Bone Black	486½	630	1116½
B, 37 pounds Grand Cayman's Phosphate	538	750	1288
C, No phosphate	504	694	1198
D, 45 pounds Thomas-Slag	552	806	1358
E, 56 pounds So. Carolina Rock	492	798	1290
F, No phosphate	432	548	980
G, 45 pounds Bolivian Guano	461	748	1209
H, No phosphate	478	524	1002
I, 52 pounds Dissolved Bone Black	491	644	1135
K, No Fertilizer of any kind	252	318	570
L, 30 pounds Muriate of Potash	279	364	643

The average yields on the three plots which received no phosphate and the largest percentage difference between the *average* yield and that of any one plot are as follows:

	Average Yield.	Percentage Difference.
Sound Ears	471	8.2
Stover	589	17.8
Total Crop	1060	13.0

The percentage increase or decrease (—) on each plot over the no-phosphate plots is as follows:

	Sound Ears.	Stover.	Total Crop.
A, Dissolved Bone Black	3.3	7.0	5.3
B, Grand Cayman's Phosphate	11.4	27.3	21.5
D, Thomas-Slag	11.7	36.9	28.1
E, South Carolina Rock	4.4	35.5	21.7
G, Bolivian Guano	—2.2	27.0	14.0
I, Double quantity Dissolved Bone Black	4.3	9.3	7.0
K, No fertilizer of any kind	—46.5	—46.0	—46.2
L, Muriate of Potash	—40.8	—38.2	—39.3

Result.—This experiment furnishes some interesting observations.

1. Plots C, F and H received nitrogen and potash alone; plot K received no fertilizer of any kind; and plot L received 30 pounds of muriate of potash only. The yields are as follows:

	Ears.	Stover.	Total.
C, F and H, (Potash and Nitrogen).....	471	589	1060
L, (Potash).....	279	364	643
K, (no fertilizer).....	252	318	570

It appears that potash alone only slightly increased the yield, but that potash and nitrogen together almost doubled it. It seems very likely, then, that nitrogenous fertilizers, rather than potash fertilizers will give the largest returns on this land.

2. The double quantity of bone black on plot I made a slight increase of crop over plot A which had half the quantity of Dissolved Bone Black.

3. All the phosphates increased the total yield somewhat. The increase in ears is very slight for it must be borne in mind that of the 12 per cent. increase noticed on B and C, 8 per cent. could fairly be attributed to differences in the quality of the land.

The increase in stover is rather more and is approximately the same on plots B, D and E.

Experiment Carried out by Mr. George F. Platt, Milford.

This experiment was on high land, sloping to the west lengthwise of the plots. The land is set with peach trees which are at present about 4½ feet high. The plots contained one-tenth of an acre each. Muriate of Potash at the rate of 320 pounds and Sulphate of Ammonia at the rate of 200 pounds per acre were broadcast over the whole, and the phosphates were broadcast on the separate plots with great care.

The corn was Hickox Improved Sugar Corn, and was planted May 26th, and cultivated in the usual way.

The crop was raised for seed and therefore was topped in September and the ears gathered Nov. 23, much later than usual on account of the extremely unfavorable weather. It was impossible to gather the stalks and weigh them accurately, both on account of the wet and of the method of harvesting the seed corn. In August there appeared to be a spot on plots A, B and C where the corn was smaller and poorer than elsewhere. No reason could be assigned for this. The stand of corn was otherwise quite even, with very few missing stalks.

Following are the results:

		Weight of Ears.
A,	26 Pounds Dissolved Bone Black	231
B,	37 Pounds Grand Cayman's Phosphate	219½
C,	No Phosphate	206
D,	45 Pounds Thomas-Slag	232½
E,	56 Pounds Ground South Carolina Rock	229½
F,	No Phosphate	215½
G,	45 Pounds Bolivian Guano	235½
H,	No Phosphate	199½
I,	52 Pounds Dissolved Bone Black	281½
K,	80 Pounds Home-mixed Complete Fertilizer	339½

Plot K did not have the muriate of potash and sulphate of ammonia that the other plots received, being outside the experimental field though close to it.

The average yield on the three plots which received no phosphates is 207 pounds and the largest percentage difference between the average yield and that of any one of the three plots is 4.1.— The percentage increase of crops on the several plots over the no-phosphate plots is as follows:

	Percentage Increase over No Phosphate Plots.
A, Dissolved Bone Black	11.6
B, Grand Cayman's Phosphate	6.0
D, Thomas-Slag	12.3
E, South Carolina Rock	10.9
G, Bolivian Guano	13.7
I, Double Quantity Dissolved Bone Black	36.0
K, Home-mixed Complete Fertilizer	64.0

Result.—It appears that Grand Cayman's Phosphate had very little effect on the crop, but remembering that plots A, B and C had each a spot where for some reason the stand of corn was weak, this result is not surprising. The double quantity of Dissolved Bone Black gave a three-fold increase; and the results generally indicate that phosphates rather than potash salts or nitrogenous matters will raise the productiveness of this land. The same increase practically is secured by Dissolved Bone Black, Bolivian Guano, Thomas-Slag and South Carolina Phosphate when applied in quantities proportional to their market price.

The Home-mixed Fertilizer on K produced five times as much increase of crop as any other application, excepting the double quantity of dissolved Bone Black.

This was put on at the rate of 800 pounds per acre, and one fifth of it was put *in the hill* instead of being all sowed broadcast like the other fertilizers.

Experiment carried out by Stephen Hoyt's Sons, New Canaan.

The experiment field had an area of 200 square rods and was perfectly level. For the last seven years nursery stock had been grown on it without any manure. It had not been in grass for 40 years. It was plowed and harrowed on the 22d and 23d of May and on it were broadcast and harrowed in 1000 pounds double sulphate of potash and magnesia and 375 pounds sulphate of ammonia. It was divided into 8 equal plots of 25 square rods each on which the phosphates were sowed as described below.

A flint corn was planted in rows 3 feet apart, hills 2 feet apart in the row and two stalks were left to a hill. The crop was cultivated in the usual way and met with no accidents. When visited by an officer of the Station in August the several plots showed a remarkably uniform stand throughout with no missing hills. The crop was cut at the usual time but could not be husked and weighed till the first week in December. Following are the results :—

Weights in Pounds of Field-Cured Crops.

(Mr. Hoyt's Experiment.)

	Sound Ears. lbs.	Soft Ears. lbs.	Stover. lbs.	Total Crop. lbs.
A, 40 pounds Dissolved Bone Black	730	200	1052½	1982½
B, 58 pounds Grand Cayman's Phosphate	840	205	1132½	2177½
C, No Phosphate	725	215	1080	2020
D, 69 pounds Thomas-Slag	750	185	1050	1985
E, 86 pounds So. Carolina Rock	590	245	1017½	1852½
F, No Phosphate	652½	185	993½	1831
G, 68 pounds Bolivian Guano	705	240	1085	2030
H, 80 pounds Dissolved Bone Black	585	236½	973½	1795

The average yields on the two plots which received no phosphates and the percentage differences between them and the average are as follows :—

	Average yield.	Percentage difference.
Sound Ears	688.7	5.3
Stover	1036.7	4.2
Total crop	1925.0	5.0

The percentage increase, or decrease [marked —] of crop on the several plots over the average of the no-phosphate plots is as follows:—

	Sound Ears.	Stover.	Total Crop.
A, Dissolved Bone Black	6.0	1.5	3.0
B, Grand Cayman's Phosphate	21.9	9.2	13.1
D, Thomas-Slag	8.9	1.2	3.1
E, So. Carolina Rock	—14.3	—1.9	—3.8
G, Bolivian Guano	2.4	4.6	5.4
H, Double quantity Dissolved Bone Black	—15.0	—6.1	—6.8

Result.—There is not a single case where an increase of yield could fairly be attributed to the phosphate except the yield of sound ears on plot B. In all other cases the slight increase observed is clearly within the limits of error and can be attributed to differences in the quality of the soil on the different plots.

The apparent *decrease* of yields on plots E and H are largely to be explained in the same way. It is evident that the soil was not relatively deficient in phosphates and for that reason could not answer the purpose of this experiment.

Summary.

The experiment made by Mr. Bartholomew with corn in 1887, the repetition of that experiment in 1888, his experiment with potatoes in 1888, Mr. Yeomans' experiment with corn in 1888 and perhaps Mr. Platt's experiment are the only ones which can fairly be regarded as contributions to the question of the relative practical value of the phosphates under experiment.

In Mr. Bartholomew's experiment of 1887 Grand Cayman's Phosphate and Thomas-Slag produced as large a crop of ears, more stover and as large a total crop as the same money value of Dissolved Bone Black produced, while ground So. Carolina Rock produced less than half as much increase of crop over land which had no phosphates.

In 1888 *with no further addition of phosphates*, the plot which the season before had received Grand Cayman's Phosphate gave three times as much increase of sound ears, over the no-phosphate plots, as the plot which had received Dissolved Bone Black, more than twice as much increase of stover and more than three times as much increase of total crop. The plot which had received Thomas-Slag gave still larger increase of crop. The plot which had ground South Carolina Rock the year before, produced in 1888 more than twice as much increase of ears and two and a half times as much increase of total crop as the Dissolved Bone Black.

These results are differently expressed in this statement of total yield of ears and total crop for the two years.

	Yield of Ears.	Total Crop.
A, Dissolved Bone Black	1040	1946
B, Grand Cayman's Phosphate	1100	2144
D, Thomas-Slag	1079	2099
E, Ground South Carolina Rock	1007½	1926
C and F, No phosphate (average)	942	1793

There was profit in dollars and cents in the use of either Dissolved Bone Black or the raw phosphates Grand Cayman's and Thomas-Slag. But *on this land, in these two years* raw phosphates paid better than superphosphates.

There was no loss perhaps in the use of South Carolina Rock. These conclusions are confirmed by the following statement of yield per acre for the two years:

	Total yield of ears for two years.	Bushels of shelled corn (80 lbs. ears to bu.)	Gain in bushels.	Cost of phosphate.
A, Dissolved Bone Black	8320	104	10	$3.36
B, Grand Cayman's Phosphate	8800	110	16	3.36
D, Thomas-Slag	8632	107	13	3.36
E, South Carolina Rock	8060	101	7	3.36
No phosphate	7536	94		

There now remains on the plots B, D, and E not removed by the crops, the following quantities of phosphoric acid which were applied two years ago.

Plot B	86.7 pounds
" D	59.3 "
" E	97.8 "

All of the phosphoric acid applied to plot A has been removed in the two crops and more beside.

Next we may consider Mr. Bartholomew's potato experiment. First on the rye land. Here the yield of potatoes both large and small was about the same on the separate plots which received equal money values of Dissolved Bone Black, Grand Cayman's Phosphate and Thomas-Slag, though the last named produced a larger proportion of small potatoes than the others. Each of these phosphates increased the yield about one quarter over that of the no-phosphate plots. Bolivian Guano increased the yield half as much and South Carolina Rock did not increase it at all. Each plot contained one-sixteenth of an acre. If we figure the crops of large potatoes to the acre and call 60 pounds of potatoes a bushel, the yields are as follows:—

	Bushels per acre of large potatoes.	Gain in bushels.	Cash value of gain.*	Cost of phosphate.
No phosphate	127	--	-----	----
Dissolved Bone Black	165	38	$19.00	$4.16
Grand Cayman's Phosphate	164	37	18.50	4.16
Thomas-Slag	156	29	14.50	4.16
South Carolina Rock	123	--	-----	4.16
Bolivian Guano	144	17	8.50	4.16

* Reckoning the potatoes at the low price of fifty cents a bushel.

The experiment on meadow land gave very different results. Here Dissolved Bone Black produced 25 per cent. of increase in total crop while neither of the other phosphates produced half as much, and the plot to which Bolivian Guano was applied, for some reason produced less than the no-phosphate plots. The yield in bushels per acre, the gains over the no-phosphate plots and the cash values of the gains are as follows :—

	Bushels per acre of large potatoes.	Gain in bushels.	Cash value of gain.	Cost of phosphate.
No phosphate	139	--	-----	----
Dissolved Bone Black	177	38	$19.00	$4.16
Grand Cayman's Phosphate	148	9	4.50	4.16
Thomas-Slag	149	10	5.00	4.16
South Carolina Rock	152	13	6.50	4.16
Bolivian Guano	131	--	-----	4.16

It appears that there was three to four times as much profit from the use of Dissolved Bone Black as from the use of the raw phosphate, *in this first crop.* It remains to see what the after effect of the different phosphates will be. At present we have no explanation to advance for the very different effects of the phosphates on two pieces of ground in the same field with the same exposure, the only difference between them being that one was inverted sod, while the other had been plowed a year and a half before and had grown rye.

We come now to consider Mr. Yeomans' experiment.

Mr. Yeomans' land like Mr. Bartholomew's is strikingly benefitted by phosphates. Any phosphate, raw or dissolved, put on in moderate quantity will pay well. It is even more strikingly benefited than Mr. Bartholomew's land. The results here are however very different from Mr. Bartholomew's. Dissolved Bone Black yielded from nearly three to ten times as much sound ears as any other phosphate. Where no phosphate was used there was scarcely any sound corn. It yielded from one and three-quarters to twice as much stover also as any raw phosphate. It is fair to say that Dissolved Bone Black on this land, this year, yielded twice the money return of any other phosphate.

At present no explanation can be given of this difference in the comparative effects of the same phosphates on different land. It is hoped that further experiments by these gentlemen may make the matter clearer. We believe that the difference will be found to be partly if not largely due to difference in season. August and early September of 1887, when Mr. Bartholomew's first experiment was tried, were months particularly favorable for the growth of corn, and during those months the raw phosphate plots which earlier in the season were noticeably backward, advanced rapidly and overtook the Dissolved Bone Black plot which had been leading them in growth. On the other hand, August and September of 1888 when Mr. Yeomans' experiment was tried were unfavorable to the growth of corn, being cold and wet and the raw phosphates which are presumably slower in affecting the crop could not be so well utilized. A repetition of Mr. Yeomans' experiment, such as

Mr. Bartholomew made in 1888, on the land used in 1887 is extremely desirable.

In Mr. Platt's experiment only the sound ears were weighed but Thomas-Slag, South Carolina Rock and Bolivian guano gave practically as large a *crop as Dissolved Bone Black.*

In general it has been shown that in some cases the raw phosphates may be more profitable to use than dissolved phosphate, that their effects are more lasting and that the immediate effect in some cases may be as great as that of the same money value of dissolved phosphate. This is a matter of great importance to users of commercial fertilizers and will receive further study on the part of the Station.

To any in the State who may wish to test the effect of raw phosphates on their land for themselves and will engage to follow the Station's directions for making the test and will report the results to the Station for general use, the Station will supply these phosphates so far as it is possible.

It is worth noting that the largest yield of sound ears per acre in the single experiments has run from 2980 pounds to 5860 pounds, or allowing 80 pounds of ears to the bushel, from 37 to 73 bushels per acre.

In conclusion it is a pleasure to acknowledge the readiness with which all those engaged in carrying out the experiments here described have accepted the plan suggested by the Station, and the care and accuracy with which the experiments have been conducted. In every case where there has been partial or complete failure, this has been due to circumstances of weather or to peculiarities of soil which could not be foreseen, not to any neglect on the part of the experimenter. Of the twelve experiments, four have value in connection with the special point which was studied, viz: the relative practical value of the different phosphates, while eight experiments have little or no value of this kind. Some of them however, show incidentally what fertilizing elements have special value for the soil under experiment. This general result is about what was anticipated and is not discouraging.

The question, which pays best, plain superphosphate or an equal money value of raw phosphate is an important one to the farmers of this State who are spending yearly more than $200,000 for phosphoric acid.

If this question can be settled at all it will be by such experiments as we have described carried out in all parts of the State by farmers with the coöperation of the Stations. Even if this question shall not be answered in a perfectly satisfactory way its study will nevertheless diffuse information and may in other ways richly repay for the labor and expense.

FEEDING STUFFS.

[For tabulated statement of Composition of American Feeding Stuffs, see page 90.]

About 200 samples of feeding stuffs have been analyzed during the last twelve months. A large number of the analyses were made in connection with the Experiment on the Effect of the Rate of Planting on the Quality and Quantity of the Maize Crop and will be given in the discussion of that experiment either in this Report or the next. Analyses of grasses will be found on page 101 in the account of the forage garden.

Analyses of potatoes are given in the account of the field experiments with potatoes made by Mr. Fenn, and Mr. Platt of Milford and Mr. Webb of Hamden. The remaining analyses follow. Some of them have already been published in Bulletin No. 96, but are reproduced here to meet the legal requirement that the Report of the Station shall contain "a full and detailed report of its operations."

Full explanations regarding feeding stuffs and their ingredients, feeding standards and the compounding of rations, etc., have been given in previous reports, copies of which can be obtained by those who wish them.

ON THE VALUATION OF FEEDING STUFFS.

It is not possible to accurately express in figures the actual feeding value or nutritive effect of a feeding stuff any more than it is possible to give a figure which shall represent the *agricultural* value of a commercial fertilizer. The reasons are alike in both cases and are evident without explanation. But some way of comparing feeds like that used for comparing fertilizers in which both their chemical composition and cost prices shall be taken account of is very desirable. A large number of mill-products are now offered for sale in this State to feeders of dairy stock. Most of them, like wheat feed, rye feed, oat feed and buckwheat middlings are residues left from the preparation of flour or meal for table use. Some are evidently worth a good deal more than is charged for them; while others are of quite inferior value. Neither buyers nor sellers know their composition nor whether the prices charged are high or low as compared with other feeds, *when their composition is taken into account.*

An attempt has been made by this Station to find out and analyze all the mill-products now in the Connecticut market whose

average composition is not already known, and also to offer some method of comparison or "valuation" for them.

The method here to be described is not a new one. It has been used abroad, where feeds as well as fertilizers are sold under guarantee as to composition and the seller is obliged to make good any deficiency. The method is perfectly logical only when the price of each feeding stuff is governed strictly by its composition. In England and Germany this appears to be much more nearly the case than in this country, where prices at present are regulated scarcely at all by the chemical composition of the feeds. Notwithstanding this the valuations obtained by the method as below described have in general agreed well with the market prices of the standard mill feeds.

An outline of the method is as follows:

The average market prices of the feeds which form the basis of calculation can be obtained from the market reports just as the market prices of nitrogen, phosphoric acid and potash are obtained from the weekly quotations of fertilizer chemicals. The chemical composition of the feeds can be determined by analysis as the composition of fertilizer chemicals is determined.

The next step is to calculate from the chemical composition of all the feeds and their retail prices, the most probable or average retail price of a pound of albuminoids or fat or carbhydrates (fiber and nitrogen-free extract together.) This problem is by no means so simple as that of determining the cost of nitrogen, phosphoric acid or potash. Each of the last-named can be bought by itself; potash for instance in muriate of potash or nitrogen in dried blood, and from the price of the muriate or the blood the cost per pound of potash or nitrogen can be directly deduced. But there are no feeds which contain only one or even only two food-ingredients. All of them contain at least three. Under these circumstances to calculate the cost of each food-ingredient can only be done algebraically by an application of the "method of least squares" so-called. The tedious details of the calculation would be out of place here. The data used for solving this problem are as follows:

By correspondence with dealers throughout the State as well as with purchasers, the average retail prices of fine feed (as distinguished from coarse feed, hay, stalks, straw, etc.) have been obtained as accurately as possible. The average composition of these feeds is known from the tables of analyses which are annu-

ally revised and published by this Station. A considerable number of analyses have also been made within the last two months of feeds new to our market, so that we have a tolerably complete statement of their composition.

The feeds used in calculating the average cost of albuminoids, fat and carbhydrates are those in the subjoined list.

The selling prices per ton are believed to represent the average for December, 1888. The explanation of the column headed "Valuation" is given further on.

FINE FEEDS, COST AND VALUATION.

	Selling Price per ton.	"Valuation."
Cotton seed meal	$27.75	$30.37
Linseed meal, old process	32.25	25.92
Wheat bran	20.50	20.22
Wheat middlings	22.00	21.20
Rye bran	21.00	19.89
Corn meal	21.50	19.59
Gluten meal	23.00	25.38
Hominy chops	21.00	23.31
Malt sprouts	17.00	20.27
Oat middlings	25.00	24.31
Rye feed	20.00	19.62
	$251.00	$250.08

The calculation based on these foods and their average composition and prices at the date named shows that the average retail cost of a pound each of albuminoids, fat and carbhydrates is as follows:

COST OF FOOD INGREDIENTS.

Albuminoids (N. × 6.25)	1.6 cents.
Fat	4.2 "
Carbhydrates	.96 "

To test the accuracy of these figures they have been applied to the feeds from which they were derived and the results are given above in the column headed "Valuation." It appears that the total calculated cost and the total actual cost agree within one dollar. It may be noted in passing that these figures differ radically from those used in Germany, which were derived in a similar way from German market quotations and which in absence of any other data have been previously applied to American feeding stuffs.

To explain their use they are here applied to the sample of Malt Sprouts, No. CCCXXXII, the analysis of which is given on page 152.

	The sample contains in 100 pounds.	The sample contains per ton.		Cost per pound.	Ton Value.
Albuminoids	23.87	477.4	@	1.6 cents.	$7.64
Fat	1.38	27.6	@	4.2 "	1.16
Carbhydrates*	58.81	1176.2	@	.96 "	11.29
					$20.09

Cost	$15.00
"Valuation"	20.09

The meaning of this statement must be clearly borne in mind. It does *not* mean that this feed is certainly worth for feeding purposes $5.09 more per ton than it costs. It does *not* mean that malt sprouts are certainly worth more than another feed which has a lower valuation. It does not mean that it is a palatable and easily digestible feed. What this numerical statement does mean is this; that in malt sprouts of this quality and price the purchaser gets the food ingredients named, for less than their average market price by $5.09. This leaves a great deal to be known about the feed, to be sure, but it nevertheless is a very useful piece of information. To illustrate: To know that potash in muriate costs 4¼ cents a pound while in sulphate it costs 5½ cents, leaves much still to be known about the agricultural uses of these two salts, and spite of the difference in cost there will be much use wisely made of the more costly one, but a knowledge of this difference is of great value to purchasers of potash salts. Just so to know that albuminoids, fat and carbhydrates cost very much less in malt sprouts or cotton-seed meal than in wheat bran, will not induce an intelligent dairyman to give up bran and feed malt sprouts or cotton seed meal wholly in its place, but it may induce him to try substituting one of these for a part of the bran or other feed which he uses, and when he finds a new feed offered he will be disposed to look not only on its gross cost but on the cost of the food ingredients in it as compared with the usual market rates. These figures are provisional and will change somewhat with the state of the market. They apply *only to one class of feeds*, namely, dry fine mill-products or brewery refuse like malt sprouts and dried brewers' grains.

* The sum of nitrogen-free extract and fiber.

ANALYSES OF FEEDING STUFFS.

Cotton Seed Bran.

CCCIII. Sold by J. E. Soper & Co., Boston, Mass. Sampled and sent by R. E. Pinney, Suffield. Cost $22 per ton in 100 lb. sacks.

	Analysis.
Water	11.99
Ash	2.18
Albuminoids	6.37
Fiber	30.83
Nitrogen-free extract	47.33
Fat	1.30
	100.00

This material contains less fat (ether extract) and no more albuminoids than hay of fair quality. The fiber probably comes from cotton seed hulls. The Cotton Seed Bran costs as much as wheat bran and is far less valuable as feed.

The "Valuation" by the method just explained is $18.13 per ton, or $4.00 less than the cost. Even this is too high an estimate because more than a third of the carbhydrates consists of fiber which is the least valuable and least digestible part of the carbhydrates.

The Columbia Cured Feed for Horses and Cattle.

CCXC. This feed claims to be made "with oats and corn as a basis, reinforced by barley, wheat, rice and rye, and embodies putting into practice a theory generally held by thoughtful horse and dairy-men, that a greater variety in feed than is usually convenient would be of advantage to the animal." "It contains no tonic or medicine of any description to create a false appetite." "We claim it to be the strongest and most nutritious feed ever offered to the public."

The analysis of this article follows. The composition of wheat bran of average quality is also given for comparison.

	"Concentrated Feed."	Wheat Bran.
Water	11.41	12.38
Ash	5.54	5.59
Albuminoids	15.06	15.36
Fiber	7.44	9.34
Nitrogen-free extract	54.83	53.50
Fat	5.72	3.83
	100.00	100.00

The claim that the feed is composed of a variety of grains is a just one. Corn, rice, oats and barley were identified with the microscope. Rye and wheat may also have been present. In chemical composition the most striking difference between the "Concentrated Feed" and wheat bran is that the feed contains about two per cent. more fat and two per cent. less fiber. Its price is $25.00 per ton and its "valuation" $21.57. Whether a desirable variety of food can more economically be provided by such ready-made mixtures as this or by purchase of the different grains singly and home-mixture must be determined by the purchaser.

"The Concentrated Feed for Horses, Cattle, Sheep, Swine, Poultry, etc."

Manufactured at Pearl Mills. For sale by the Concentrated Feed Co., 33 Wendell St., Boston, Mass.

"There has been nothing invented for years," says the manufacturer's circular, "which has proved such a blessing to all classes of domestic animals as the above feed."

The directions which accompany the feed, show that it is offered as a medicinal or condimental food. Thus we read, "For an ordinary working or driving horse feed one single handful of the feed with one-fourth less his usual allowance of grain at each feed, wet or dry. For worms, twice the quantity for five days." For cows, "feed one half-pint or single handful of the feed with the usual amount of grain, wet or dry. For Garget, feed twice the quantity until it entirely disappears." Still more startling is the announcement, "this disease," hog cholera, "in its most malignant form yields readily to the free use of the Concentrated Feed."

Following the claims of the seller and the directions for use are the usual number of testimonials from those who have used the feed with satisfaction.

This material, or a similar one under the same name, has been sold more or less in the State since 1882, and in the report for 1884, page 111, its merits were fully discussed. During the present year a sample was received from W. H. Hammond, Hampton, Conn., who says in regard to it: "The cost price is 6 cents per pound and is in 12 pound bags to be sold for $1.00 or 8 cents per pound." "The above price" (6 cents per pound),

"is as given me at ton lots, or 3 tons for $300." "I have tried it and think it not up to the mark as advertised in their circular." The sample sent by Mr. Hammond was analyzed and reported to him and was also published in our weekly statement No. 41, of Sept. 15. The analysis is as follows:

	Concentrated Feed. CCLXXXVIII.	Wheat Bran.
Water	11.39	12.38
Salt	13.20	....
Other mineral matters	4.11	5.59
Albuminoids	14.87	15.36
Fiber	4.48	9.34
Nitrogen-free extract	47.42	53.50
Fat	4.42	3.83
	100.00	100.00

This "invention" which has proved "a blessing to all classes of domestic animals," apparently consists of a mixture of wheat and corn with 13 per cent. of salt and perhaps a little of some more concentrated feed. Disregarding the salt, an equal weight of wheat bran would supply as much nutriment and would cost perhaps $20.50 per ton. The "invention" costs $100 per ton in 3 ton lots or at the rate of $160 per ton in small quantities.

The Concentrated Egg Producer.

Made by the Concentrated Feed Co., No. 14 Wendell St., Boston, Mass. A sample of this material furnished by Mr. Hammond of Elliott, had the following composition.

	CCLXXXIX.
Water	10.15
Salt	17.20
Other mineral matters	6.40
Albuminoids	14.19
Fiber	3.37
Nitrogen-free extract	44.94
Fat	3.75
	100.00

The mineral matter contains a quite insoluble oxide of iron. The Egg producer has a somewhat lower feeding value probably

than the Concentrated Food for Cattle. It contains both corn and wheat and some more concentrated feed. Wheat bran contains, pound for pound, as much nutriment. The cost of the Concentrated Egg Producer is 50 cents a pound or a dozen pounds for $4.00. This latter price is equivalent to $660 per ton.

As food, neither the Concentrated Feed for Cattle or the Egg Producer are worth more than a small fraction [about one-fifth in the case of the Feed for Cattle and one-thirtieth in the case of the Egg Producer] of what they cost. As condiments they are worthless. It has been abundantly proved that condimental foods have no advantage over others by reason of the condiments in them.

As medicines, they may well be distrusted in view of the absurd claims made by the seller.

Wheat Feeds.

CCCXLVI. Spring Wheat Bran. Sold by A. Arnold & Co., Willimantic.

CCCL. Choice Bran. Sold by Paine Bros., Milwaukee.

CCCXLIII. Fine Spring Wheat Bran. Sold by E. A. Buck & Co., Willimantic.

CCCXLIV. Fine Spring Wheat Bran. "Fine Feed No. 1," or "Middlings." Sold by A. Arnold & Co., Willimantic.

CCCXLV. Fine Spring Wheat Bran. "Fine Feed No. 2," or "Middlings." Sold by A. Arnold & Co., Willimantic.

CCCXLIX. Fine Middlings. Sold by Paine Bros., Milwaukee.

CCCLI. Flour Middlings. Sold by Paine Bros., Milwaukee.

CCCXLVIII. Special Middlings. Sold by Paine Bros., Milwaukee.

The Willimantic samples were sent by N. P. Perkins, Esq., the Milwaukee samples by C. M. Ely, Esq., Harwinton.

The quotations given by Mr. Perkins were for ton lots. Those by Mr. Ely were for mixed car lots at Boston points. In the statement of costs which follows one dollar per ton has therefore been added to the quotations of Mr. Ely which is about the difference between car lots and ton lots.

ANALYSES.

	Spring Bran. CCCXLVI.	Choice Bran. CCCL.	Fine Spring Bran. CCCXLIII.	Fine Spring Bran Fine Feed No. 1. CCCXLIV.	Fine Spring Bran. Fine Feed No. 2. CCCXLV.	Fine Middlings. CCCXLIX.	Flour Middlings. CCCLI.	Special Middlings. CCCXLVIII.
Water	10.77	10.89	12.22	11.64	12.20	12.10	12.75	12.45
Ash	6.03	6.05	5.07	3.99	4.32	3.78	2.41	3.87
Albuminoids	17.12	16.69	16.06	18.06	17.75	18.12	18.81	18.50
Fiber	9.35	8.74	6.67	5.39	5.48	5.76	1.40	5.08
Nitrogen-free extract	51.68	53.15	56.36	56.13	55.40	55.34	60.31	56.60
Fat	5.05	4.48	3.62	4.79	4.85	4.90	4.32	3.50
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Cost per ton	$20.00	$20.25	$21.00	$21.00	$21.00	$20.75	$25.25	$23.50
"Valuation" per ton	21.43	20.98	22.20	21.61	21.44	21.65	21.50	20.70

It appears that cost and valuation agree very closely, and that the valuation is slightly higher than cost except in flour middlings and special middlings where the cost is considerably above valuation, probably because these brands can be used to some extent for human food.

MAIZE KERNEL AND MEAL.

Old and New Crop compared.

CCCXLI. No. 2 New York Corn. *Old Crop.* Sold by Bradley & Davis, New Haven. Cost, 56 cents per bushel.

CCCXXVI. No. 2 High Mixed Corn. *Old Crop.* Sent by C. L. Gold, West Cornwall. Cost, 56 cents per bushel. A struck bushel weighs 58 pounds.

CCCXXIX. No. 2 High Mixed Corn. *New Crop.* Sent by C. L. Gold. Cost, 46 cents per bushel. A struck bushel weighs 50 pounds.

CCCXXXIX. Good Western Corn. *New Crop.* Sent by C. E. Lyman, Middlefield. Cost, 46 cents per bushel *in car lots.*

CCCXL. Mason Co. Yellow Corn of best quality. *New Crop.* Sold by Bradley & Davis, New Haven. Cost, 53 cents per bushel.

CCCXLII. New Corn Meal. Sold by E. A. Buck & Co., and sent by N. P. Perkins, Willimantic.

CCCXLVII. Old Corn Meal. Sold by A. Arnold & Co., and sent by N. P. Perkins, Willimantic.

ANALYSES AND VALUATIONS.

	Maize Kernel.					Maize Meal.	
	CCCXLI. No. 2. Old Crop.	CCCXXVI. High Mixed. Old Crop.	CCCXXIX. High Mixed. New Crop.	CCCXXIX. Wesh'n Corn. New Crop.	CCCXL. Best Yellow. New Crop.	CCCXLII. From New Corn.	CCCXLVII. From Old Corn.
Water	14.64	13.09	20.00	19.73	20.30	17.42	14.61
Ash	1.12	1.20	1.25	1.06	1.10	1.26	1.18
Albuminoids	9.30	9.40	8.06	8.68	8.40	8.00	8.87
Fiber	1.42	1.53	1.54	1.61	1.38	1.38	1.35
Nitrogen-free extract.	69.57	70.67	65.38	64.87	65.20	68.65	69.96
Fat	3.95	4.11	3.77	4.05	3.62	3.29	4.03
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Cost per ton	$20.00	20.00	16.42*	16.42*	18.92	19.00	19.00
"Valuation" per ton.	$19.93	20.32	18.60	18.93	18.51	18.50	19.65

The new crop corn contains over six per cent. more of water than old crop corn, and correspondingly less of food-ingredients. This additional water makes the corn, and especially the meal ground from it, more liable to spoil by heating. It also makes the kernels plumper and considerably lighter, bulk for bulk, than old corn. Repeated trials have shown that old corn of the best quality weighs from 58 to 59 pounds per struck bushel, while a bushel of the best new corn weighs only 50 to 52 pounds.

The valuation of the new corn is about $1.45 per ton less than that of old corn, which represents a difference of 4 cents per bushel; and this seems to be about the difference made in dealers' quotations.

OATS AND OAT MIDDLINGS.

CCCXXIV. Mixed Oats, No. 2. 34 pounds in the bushel. Cost 33 cents per bushel of 32 pounds.

CCCXXV. White Oats, No. 2. 32 pounds to the bushel. Cost 34¾ cents per bushel.

Both samples were sent by C. L. Gold, West Cornwall.

CCCXXI. Oat Middlings. From Betts & Alling, New Haven, cost $25.00 per ton. This is the residue from mills where oat meal is prepared. It is claimed that only the brightest and heaviest oats can be used for the purpose. The quality of the middlings of course depends both on the oats and also on the

* In car lots. Probably about $17.80 to $18.00 by the ton.

way they are ground and screened. To illustrate this an analysis is given below, made in 1886, of oat middlings from a different source.

ANALYSES.

	Oats.		Oat Middlings.	
	CCCXXXIV.	CCCXXV.	CCCXXI. Betts & Alling.	CCXVII. B. F. Case.
Water	11.59	11.28	9.19	8.19
Ash	3.15	3.59	3.24	4.24
Albuminoids	14.25	12.43	20.00	12.64
Fiber	7.78	9.77	3.80	12.48
Nitrogen-free extract	58.12	57.69	56.19	56.31
Fat	5.11	5.24	7.58	6.14
	100.00	100.00	100.00	100.00
Cost per ton	$20.62*	21.71*	25.00	
"Valuation" per ton	21.50	21.34	24.29	

The analyses of the oats show nothing to warrant a difference of $1.00 in the price of the two samples. The White Oats are brighter, though not as heavy as the Mixed Oats. Mixed Oats ground with corn make the meal dark-colored and so lessen its market-value if not its feeding-value.

Rye Feed and Barley Screenings.

CCCXX. Rye Feed. The residue from the manufacture of rye flour. From Betts & Alling, New Haven. Cost $20.00 per ton.

CCCXXII and CCCXXVII. Barley Screenings. Sent by C. L. Gold, West Cornwall. The two samples differ in price by $2.00 per ton, which represents the cost of grinding. CCCXXVII is fine ground.

ANALYSES.

	Rye Feed.	Barley Screenings.	
	CCCXX.	CCCXXII.	CCCXXVII.
Water	12.77	12.42	12.02
Ash	2.62	3.60	3.51
Albuminoids	13.56	12.12	12.50
Fiber	2.75	7.62	7.00
Nitrogen-free extract	65.80	61.60	62.03
Fat	2.60	2.64	2.94
	100.00	100.00	100.00
Cost per ton	$20.00	15.00†	17.00
"Valuation" per ton	19.59	19.39	19.72

* In car lots.

† In car lots. By the single ton the prices would probably be from $1.00 to $1.50 higher.

Buckwheat Middlings.

A mill-product obtained in making buckwheat flour. Made by the Quinnebaug Store, Danielsonville.

CCCXXXVII. Made in December, 1888. CCXIII. Made in 1886.

Analyses.

	CCCXXXVII.	CCXIII.
Water	13.71	16.33
Ash	4.35	5.50
Albuminoids	31.25	30.31
Fiber	5.70	4.02
Nitrogen-free extract	36.93	36.29
Fat	8.06	7.55
	100.00	100.00

Cost per ton	$21.00
"Valuation" per ton	24.95

This is one of the cheapest and richest feeds in market and in the opinion of some who are using it is unsurpassed in favorable effect on the quality and quantity of the milk-yield.

Various Feeds.

CCCXXVIII. Old Process Linseed Meal. Price, $27.00 per ton in car lots. Sent by C. L. Gold, West Cornwall.

CCCXXXI. "Gluten No. 1 Feed," also called Dry Sugar Feed. Price, $19.70 per ton in Middlefield in car lots.

CCCXXXII. Malt Sprouts from a Meriden brewery. Price, $15.00 per ton.

The last two samples were sent by C. E. Lyman, Middlefield.

CCCXXXIII. Apple Pomace from J. H. Dickerman, Mt. Carmel.

	Old Process Linseed Meal. CCCXXVIII.	Gluten No. 1 Feed. CCCXXXI.	Malt Sprouts. CCCXXXII.	Apple Pomace. CCCXXXIII.
Water	10.27	11.66	10.10	69.90
Ash	5.12	.56	5.84	.71
Albuminoids	36.06	17.81	23.87	1.58
Fiber	7.36	3.08	10.76	4.86
Nitrogen-free extract	34.53	59.56	48.05	21.24
Fat	6.66	7.33	1.38	1.71
	100.00	100.00	100.00	100.00
Cost per ton	$27.00	19.70	15.00	?
"Valuation" per ton	$25.16	23.88	20.02	

In Linseed Meal, albuminoids, fat and carbhydrates cost more than in any other concentrated feed which is in common use.

Gluten No. 1 Feed is made in Buffalo, N. Y., and is a waste product from the manufacture of glucose. Its digestibility has not been determined, but it is probably not greatly inferior to corn meal in this regard, and at the price named is a cheap feed, considered simply from the point of view of composition as shown by the analysis. By the single ton it would cost from $1.00 to $2.00 more than by car load. It has been used by a few farmers in Wallingford and is thought to be excellent for producing milk and butter.

Apple Pomace is prized by those who have it as a food for cattle and horses. This sample, which is free from straw and consists wholly of the apple "cheese" from the cider press, contains about as much albuminoids, ten per cent. more carbhydrates and four times as much fat (ether extract) as green fodder maize. It has a faint vinous smell and contains about a quarter of one per cent. of free acetic acid. Ensilaged like maize fodder it would be a valuable winter feed.

Starch Feed and Sugar Feed.

CCCXXXVIII. Glen Cove Starch Feed. Sold by Bradley & Davis, New Haven. Cost, 20 cents per bushel. (A bushel should weigh, on the average, 60 pounds.) Sampled by a Station Agent.

CCCLII. Buffalo Sugar Meal. Made by The American Glucose Co., Buffalo, N. Y. Sampled and sent by C. L. Davis, New Haven. Cost, 13 cents per bushel *in car lots*. A bushel is stated to weigh 50 pounds.

	CCCXXXVIII. Starch Feed.	CCCLII. Sugar Meal.
Water	66.53	62.91
Ash	.25	.15
Albuminoids	6.01	3.27
Fiber	2.00	2.00
Nitrogen-free extract	22.47	27.60
Fat	2.74	4.07
	100.00	100.00
Cost	$6.66*	5.20†
"Valuation"	8.92	10.15

The Glen Cove Starch Feed has a slightly sour smell; the Buffalo Sugar Meal has a much more pronounced smell, reminding

* By the single bushel. † By the car lot.

one of cheese, but it is said to be greatly relished by cattle. Both feeds are wet and pasty. Nearly two-thirds of their total weight is water.

Meat.

CCCXXX. This sample consists of refuse meat, thoroughly cooked, probably to remove grease, and packed in barrels. It is sold for $1.00 per 100 pounds in Worcester, Mass., and is fed to poultry. It keeps in cold weather for a good while without developing a particularly disagreeable odor. Sampled and sent by Andrew Kingsbury, Coventry.

Analysis.

Water	55.44
Ash	2.20
Albuminoids	35.36
Nitrogen-free extract	1.34
Fat	5.66
	100.00

FURTHER OBSERVATIONS ON THE MECHANICAL ANALYSIS OF SOILS.

By Thomas B. Osborne, Ph.D.

In continuation of this subject, some experiments have been made on boiling clayey soils with water. The boiling was carried on gently in a platinum retort connected by ground joints with a platinum condenser and heated by a lamp flame.

In describing these experiments the word *clay* will be used exclusively to designate that material which, after stirring up with a large volume of water, 200 mm. in depth, remains 24 hours in suspension, and which has been determined by precipitation by ammonium nitrate, ignition and weighing.

The first trials were made on North Haven "Brick Clay" from the same source but of a different sampling and different composition to those employed in former work.

Ten grams of this North Haven clayey soil were boiled in platinum with 100 c.c. of pure water for 3 days (72 hours) continuously with but slight diminution of the volume of water. At the end of this time the soil settled readily, the clay having become flocculent, leaving the water nearly clear. The boiling

was resumed and continued for 6 days longer. On then pouring off the contents of the retort into a beaker, the clay settled promptly with much the appearance of dense ferric hydroxide, leaving the water but slightly turbid. There remained, however, a considerable portion adhering to the walls of the retort which had a pasty character and could only be removed by rubbing. This was detached with as little disturbance as possible and the entire sample was then suspended in about one gallon of distilled water having a depth of 200 mm., and let stand for 24 hours. The turbid liquid was then decanted from the sediment and the suspended clay thrown down by ammonium nitrate.

The sediment was again stirred up with distilled water as before, again left to settle for 24 hours, and a second portion of clay thus obtained in suspension was determined.

The sediment thus obtained was thoroughly pestled as described in report of this Station for 1886, pp. 148 and 153, stirred up with water and clay determined as before.

The results of this treatment were as follows:

	Per cent.
Clay obtained by boiling, 1st sedimentation	6.96
Clay obtained by boiling, 2d "	2.73
Clay obtained by pestling	9.78
Total	19.47

Ten grams of the same sample were passed through a ¼ mm. sieve and without further treatment stirred up with 1 gallon of water 200 mm. deep. After 24 hours' subsidence 3.88% of clay were found in suspension.

Ten grams of the same sample were thoroughly pestled and mixed with 1 gallon of water as before, when 17.74% of clay remained in suspension.

Ten grams of the same sample were boiled for 23 hours in platinum with 100 c.c. water. On opening the retort it was found that only about 30 c.c. water remained. When transferred to a beaker with 150 c.c. water the sand settled promptly, and afterwards a layer of coagulated clay about ⅛ inch thick was deposited. The entire sample was then transferred to a large jar holding 1 gallon of water 200 mm. deep and allowed to settle 24 hours. There remained in suspension 6.25% clay.

Ten grams were boiled with 150 c. c. water in platinum for 96 hours without appreciable loss of liquid. The clay did not

adhere to the vessel and was densely flocculent. Nine-tenths of the slightly alkaline liquid were filtered off and left on evaporation a residue of .0163 grm., which contained .0056 grm. silica and .0057 calcium carbonate, besides traces of phosphoric and sulphuric acids and magnesia.

Summary of results on North Haven clayey Soil.

	Per cent.
Clay obtained without boiling or pestling	3.88
" " after boiling 23 hours	6.25
" " " " 216 " 1st sedimentation	6.96
" " " " 216 " 2d "	2.73
" " " " 216 " and subsequent pestling	19.47
" " " simply pestling	17.74

Ten grams of a sample of Red Clay from Dakota were boiled in platinum retort with 150 c. c. distilled water for 7 days (168 hours) and the clay capable of remaining in suspension was determined as before and amounted to 27.76%. The same sample after thorough pestling gave 33.36%. In this case the clay showed no signs of flocculating.

The foregoing results agree in general with those previously obtained by boiling in glass. Here we have eliminated the effect of any soluble matter extracted from the glass. No advantage to be derived from boiling is indicated, the difference of 1.73% between the last two items in the above summary being probably within the limits of experimental error.

No evidence is, however, obtained to show that the clay in these samples is made granular from dehydration, or is by prolonged boiling otherwise rendered less susceptible of suspension in water.

The coagulation of the North Haven clay is doubtless due to soluble matter extracted by water from the clay itself.

The superiority of pestling over boiling for the disintegration of clay is made very evident.

The determination of clay by precipitating either with ammonium chloride or by non-volatile salts presents some difficulties. In the latter case the clay must be filtered and washed in order to remove the precipitant, which is a difficult and tedious matter, and then involves the removal of the clay from the paper and the complete incineration of the latter. This is by no means easy. With ammonium chloride the greater part of the solution

can be removed by decantation and the remainder evaporated to dryness and the clay ignited. In such case iron will be lost from the clay through volatilization, as ferric chloride. These difficulties are avoided by using ammonium nitrate which is an excellent precipitant and occasions no loss of iron during ignition. A large part of the ammonium nitrate may be removed before ignition by bringing the clay to dryness in a platinum dish and then filling the dish with hot water. The clay will all remain at the bottom of the vessel and the clear solution can be removed with a pipette. If this process is repeated two or three times there will be but little ammonium nitrate to remove on ignition, and consequently but little trouble will be occasioned by snapping which is otherwise liable to occur.

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STATE OF CONNECTIC

ANNUAL REPORT

OF

The Connecticut Agricu

EXPERIMENT STATI

For 1889.

PRINTED BY ORDER OF THE GENERAL A

NEW HAVEN, CONN.:
TUTTLE, MOREHOUSE & TAYLOR, PRI
1890.

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STATE OF CONNECTICUT.

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ANNUAL REPORT

OF

The Connecticut Agricultural

EXPERIMENT STATION

For 1889.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN, CONN.:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
1890.

JUN 24 1890

OFFICERS AND STAFF FOR 1889.

STATE BOARD OF CONTROL.

Ex-officio.

HIS EXC. MORGAN G. BULKELEY, *President.*

Appointed by Connecticut State Agricultural Society:	Term expires
HON. E. H. HYDE, Stafford, *Vice-President.*	July 1, 1891.
Appointed by Board of Trustees of Wesleyan University:	
PROF. W. N. RICE, Middletown.	1891.
Appointed by Governor and Senate:	
EDWIN HOYT, New Canaan.	1892.
H. L. DUDLEY, New London.	1893.

EXECUTIVE COMMITTEE.

Appointed by Board of Agriculture:

T. S. GOLD, West Cornwall. 1892.

Appointed by Governing Board of Sheffield Scientific School:

W. H. BREWER, New Haven, *Secretary and Treas.* 1890.

Ex-officio.

S. W. JOHNSON, New Haven, *Director.*

Chemists.

E. H. JENKINS, PH.D., *Vice-Director.*
A. L. WINTON, JR., PH.B.
T. B. OSBORNE, PH.D.
R. S. CURTISS, PH.B.

Mycologist.

ROLAND THAXTER, PH.D.

Stenographer and Clerk.

MISS F. M. BIGELOW.

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helpers.

HUGO LANGE.
HERRMANN GERCHEWSKI.

ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established in accordance with an Act of the General Assembly, approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food. seeds, milk, and other agricultural materials and products, to identify grasses, weeds, useful or injurious insects, moulds, blights, mildews, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station makes analyses of Fertilizers, Seed-Tests, etc., etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.

2. That the samples are taken from stock now in the market, and in accordance with the Station instructions for sampling.

3. That the samples are fully described and retail prices given on the Station "Forms for Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs and like Associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.

All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the use of individuals will be charged for at moderate rates. The Station will undertake no work, the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of general interest will be published in Bulletins, of which copies are sent to each Post Office in this State, and to every citizen of the State who applies for them. These results will be summed up in the Annual Reports made to the Governor.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agricul-

ture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties, sent on application.

☞ Parcels by Express, to receive attention, should be *prepaid*, and all communications should be directed, *not to any individual officer*, but simply to the

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

☞ Station Grounds, Laboratories and Office are on Suburban st., between Whitney avenue and Prospect st., 1⅛ miles North of City Hall. Suburban st. may be reached by the Whitney ave. Horse Cars, which leave the corner of Chapel and Church sts. three times hourly, viz: on the striking of the clock and at intervals of twenty minutes thereafter.

☞ The Station has Telephone connection and may be spoken from the Central Telephone Office, 118 Court st., or from Peck & Bishop's Office in Union R. R. Depot.

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REPORT OF THE BOARD OF CONTROL.

To His Excellency, Morgan G. Bulkeley, Governor of Connecticut:

In compliance with the law establishing the CONNECTICUT AGRICULTURAL EXPERIMENT STATION, the Board of Control herewith submits its Annual Report:

Since the last report was made a new mycological laboratory has been put in operation. A special study was made by Dr. Thaxter during last winter and spring of the onion smut which has done great damage to the onion crop, particularly in the shore towns of Connecticut. Field experiments with a view of checking the ravages of this fungus disease were made by Dr. Thaxter during last spring and summer. An account of these experiments and of the success which has attended them, as well as of the other work of this department will be found in his report to the Director. During last season fungus diseases have done greater damage to our crops than is commonly the case, because of the continuous wet weather during the summer months. The constant calls made upon the Station's mycologist for information and help, especially by fruit growers, indicate that the establishment of this department by the Board of Control last year was a wise measure.

The sampling of fertilizers has been thoroughly done according to the plan followed for the last two years, and analyses have been made of every brand sold in Connecticut.

Field experiments have been carried out in different parts of the State.

Examinations of butter and molasses required by the Dairy Commissioner have been made as usual and expert evidence furnished when required in court.

Much work has also been done in other directions the results of which it has not been possible to prepare for publication at this time, but they will be fully presented in the report of the Director which is now being written.

The report of the Treasurer is herewith appended. It exhibits the financial affairs of the Station for the fiscal year ending June 30th and shows the amounts received from the several sources, the amounts spent for various purposes, what part of each has been paid from the National appropriation and what part from home receipts.

All of which is respectfully submitted:

WM. H. BREWER, *Secretary.*

November 1st, 1889.

REPORT OF THE TREASURER.

WM. H. BREWER, *in account with the Connecticut Agricultural Experiment Station.*

FOR THE FISCAL YEAR ENDING JUNE 30TH, 1889.

RECEIPTS.

Balance	$ 6.24	
From State Comptroller	8,000.00	
From U. S. Treasurer	7,500.00	
Analysis fees due from previous fiscal year	835.00	
Analysis fees due and collected this year	3,494.50	
Miscellaneous receipts	34.55	
		$19,870.29

EXPENDITURES.

	State Acc't.	U. S. Acc't.	
Salaries	$5,130.00	$5,906.25	$11,036.25
General Laboratory expenses	1,045.03	73.60	1,118.63
Mycological Investigation		199.68	199.68
Grass and Forage Investigation	191.62		191.62
Field Experiments		384.66	384.66
Gas	263.16		263.16
Water	139.50		139.50
Coal	147.50		147.50
The Establishment, Buildings, Grounds, etc.	451.43		451.43
Telephone		100.00	100.00
Printing	187.15	256.46	443.61
Stationery	112.53		112.53
Postage	76.47		76.47
Library	222.40		222.40
Mycological Library		204.35	204.35
Collecting Fertilizers	561.75		561.75

	State Acc't.	U. S. Acc't.	
New Mycological Laboratory	$2,818.73	$375.00	$3,193.73
Changes in old buildings	738.84		738,84
Insurance	91.50		91.50
Traveling Expenses of the Board	7.50		7.50
Unclassified sundries	185.18		185.18
	$12,370.29	$7,500.00	$19,870.29

MEMORANDUM.

The year's accounts were audited October 8th, 1889, by the Auditors of the State Public Accounts. Analysis fees on certain fertilizers sold in the State during the season of 1888 and due before June 30th, but not received by the Treasurer until after July 1st, are placed in this year's receipts; and analysis fees which may have been due this year before June 30th but not collected until after, will go into the new account.

WM. H. BREWER, *Treasurer.*

REPORT OF THE DIRECTOR.

During April and May last, the agents of the Station visited 127 towns and villages in all parts of the State and drew about 580 samples representing the one hundred and thirty-two different brands of commercial fertilizers which have been legally sold in the State during the year. Of each of these the Station is required by law to make and publish annually at least one analysis. Examinations of home-mixed fertilizers, manures and waste products have brought up the total number of this class of analyses to 242. Each analysis has been made in duplicate and as a rule the duplicates have been executed by different chemists.

56 analyses of feeding stuffs other than grasses and hay have been made within the year.

In connection with studies in the forage garden and a preliminary examination of some of the salt marshes of the State, 53 samples of grasses cut in different stages of growth have also been analyzed.

28 samples of maize kernel, cob, and stover, and 20 samples of potatoes have been examined to supplement the field experiments carried out in different parts of the State.

On the application of Mr. Tatem, the State Dairy Commissioner, 183 samples of vinegar, 45 of molasses, and 13 of suspected butter have been examined and evidence has been furnished in court when required for the prosecution of violators of the laws regarding butter and molasses.

Much time has been given by Dr. Osborne to a study of the nitrogenous matters contained in the kernels of maize and oats.

Considerable work has also been done by others of the Station Staff in testing and improving analytical methods, a branch of investigation which is of special importance at the present time and one which receives too little attention.

The field work of the Station has been as follows:

1. Elaborate experiment on the influence of distance of planting on the quantity and quality of the maize crop.

This has been continued from last year on the farm belonging to the estate of the late J. J. Webb, of Hamden. The results obtained in 1888 constitute Part I. of this Report.

2. On the relative agricultural value of superphosphate and various raw phosphates. Experiments conducted by W. I. Bartholomew, Putnam; W. H. Yeomans, Columbia; C. A. Sill, Saybrook; M. H. Dean, Lime Rock, and Lawrence Doyle, Harwinton.

3. On the effect of size and method of cutting seed potatoes on the quality and quantity of the crops, and, if carried on for a term of years, on the qualities of the variety. Experiments conducted on the estate of J. J. Webb and by Dennis Fenn and George F. Platt, of Milford, and C. A. Sill, of Saybrook.

4. Studies of the grasses of the salt marshes of Connecticut.

5. Studies of our native and introduced meadow grasses in the forage garden at the Station.

The laboratory and field work of the mycologist of the Station, Dr. Thaxter, are fully described in his report, pp. 127–178.

During 1889 the Station has issued five printed Bulletins aggregating 68 printed pages. These bulletins are now distributed in editions of 7500 and the demand for them is constantly increasing.

The Station correspondence has also considerably increased. During the last 12 months more than 1900 letters and manuscript reports have been sent from the Station.

Late in October, by our invitation, the State Board of Agriculture held a field-meeting at the Station attended by more than 100 farmers and their families.

A particular account of the results of the Station work during the year will be found in the following pages.

NOTE.—The investigation which is described on the following pages, 9 to 48, was made in 1888, but the results could not be prepared for publication in season for the Station Report of that year. They were accordingly printed in March, 1889, as Part I of the Annual Report for 1889. A continuation of this experiment in 1889 is described on pages 219–231 of this Report.

THE EFFECT OF THE RATE OR DISTANCE OF PLANTING ON THE QUANTITY AND QUALITY OF THE MAIZE CROP.

Indian Corn or Maize is our staple crop. More bushels of Indian Corn are raised in this State yearly than of all the other cereals together and nearly five-eighths of the acreage devoted to cereals is planted to this grain.

Maize varies more than any other cereal under changed circumstances of climate and culture and it is preserved and used for cattle food in a greater variety of ways; sometimes the whole plant is used for soiling, or for ensilage, or is fed unhusked in its field-cured condition, and at other times the largest possible yield of marketable ears is aimed at, making little account of the stover. Maize is suited to all these uses chiefly in three ways, viz: by selection of proper varieties, by cutting the crop at different stages of growth and lastly by the rate of planting.

Various experimenters in this country as well as abroad have studied the effects of rate or distance of planting on the total yield of maize and on the yield of sound ears and shelled corn. No thorough study has however been made in the United States of the effect of rate of planting both on the total yield and at the same time on the chemical composition and so on the food-value of the whole crop. The importance of the subject led this Station to undertake such a study with the assistance of Mr. J. J. Webb, of Hamden, and the results thus far obtained are given in the following pages.

The proof sheets were ready to be submitted to Mr. Webb for suggestion or correction when he was seized by a fatal illness. His death removes a firm supporter and ardent friend of this Station which he helped to establish and to manage during the

first years of its existence, a farmer of rare intelligence, enterprise and business ability, and a thoroughly honest, honorable and generous citizen.

The details of the method of investigation are first given, then the tabulated statements of results, and lastly a general discussion of some of the results and their bearing on farm practice.

The object has not been to establish any special rule with regard to the rate of planting Indian Corn. The best possible rate of planting depends on a variety of conditions which are never precisely alike in any two seasons or on any two farms and therefore a fixed rule regarding it is impossible. No one rate will *every* year give the largest possible crop for that given year and land, but a certain distance of planting may *on the average* through a term of years be expected to give the best results. Many who grow corn in this State have doubtless been led by the experience of years to adopt such a distance of planting and the most intelligent agricultural practice is generally the safest guide.

But a clearer idea of the conditions of growth which are affected by the rate of planting and of the general effect of rate of planting on the quality as well as the quantity of the harvest will help to make our agricultural practice more intelligent.

DETAILS OF THE EXPERIMENT.

The Field.

Mr. Webb, very kindly set aside for the experiment an acre and a half of level meadow land which had been in grass for five years, and was in fair condition as regards fertility. He also most generously put at our disposal his men, teams and tools at such times as they were needed throughout the season.

After plowing and harrowing, the piece was laid out in three parallel strips, each about 408 feet long and 68 feet wide running north and south. A four-foot space separated these strips.

On two adjacent strips an ammoniated superphosphate was very evenly sown broadcast with a machine at the rate of 1,000 pounds per acre. On the third strip, the same superphosphate was sown at the rate of 2,000 pounds per acre. This superphosphate contained 4 per cent. of nitrogen, 7 per cent. of potash and 9.8 per cent. of phosphoric acid. It was prepared by mixing thoroughly—

185	pounds	sulphate of ammonia.
140	"	dried blood.
185	"	muriate of potash.
780	"	dissolved bone black.
1290	"	

The whole field was then thoroughly harrowed. In the next place each strip was accurately divided into six plots, each 64 feet long [68 feet wide], with four foot spaces between them. The general arrangement is shown in the following diagram, Table I. The measurements were all carefully made and afterwards verified by another person to insure accuracy. Each plot contained 4,352 square feet or very nearly one-tenth of an acre. For ready reference the plots were lettered as in the diagram. Afterwards the field was marked and drills opened four feet apart running north and south.

Planting and Cultivation.

The planting was done on the 23rd and 24th of May except plots M to Q which were planted May 29th. This delay was unintentional but unavoidable.

The seed planted on the first series of plots, from A to F was a large dent variety of maize known as White Edge Dent. Mr. Webb has raised it for years with perfect satisfaction, but this locality is probably about as far north in New England as will admit ripening without injury by frost. On the second series of plots, from G to L was planted a small flint variety of maize called Rhode Island White Cap. The seed was given to us by Mr. Bartholomew of Putnam, who has raised it for many years, and improved it by selection. This variety is hardy any where in the State. The same variety was planted on plot R, the intention being to use it also on plots P and Q but unfortunately our supply of seed failed and plots M to Q were therefore planted with the White Edge Dent mentioned above. The planting was done wholly by hand and by the working force of the Station.

The design was to grow one stalk to every four feet in the row [rows 4 feet apart] on the most southerly plots, A, G and M; one stalk to every two feet, on the next plots, B, H and N; one stalk to a foot on plots C, I and O; two stalks to a foot on D, J and P; four stalks to a foot on the next plots and eight stalks to a foot on plots F, L and R.

TABLE. I.—DIAGRAM OF THE FIELD.

North.

F 8704 plants. $\frac{1}{4}$ square foot to a plant. 8 stalks to a foot in the row.		L 8 stalks to a foot.		R 8 stalks to a foot.
E 4352 plants. 1 square foot to a plant. 4 stalks to a foot in the row.		K 4 stalks to a foot.		Q 4 stalks to a foot.
D 2176 plants. 2 square feet to a plant. 2 stalks to a foot in the row.		J 2 stalks to a foot.		P 2 stalks to a foot.
C 1088 plants. 4 square feet to a plant. 1 stalk to a foot in the row.		I 1 stalk to a foot.		O 1 stalk to a foot.
B 544 plants. 8 square feet to a plant. 1 stalk every 2 feet in the row.		H 1 stalk every 2 feet.		N 1 stalk every 2 feet.
A 272 plants. 16 square feet to a plant. 1 stalk every 4 feet in the row.		G 1 stalk every 4 feet.		M 1 stalk every 4 feet.

South.

Plots A to F and M to Q were planted with White Edge Dent maize.
Plots G to L and plot R were planted with R. I. White Cap, a flint maize.

A measuring line was used in each drill and the kernels dropped very accurately in place. An extra quantity was planted to insure a perfect stand and to be thinned out where necessary. In one or two spots, particularly on plot H, moles destroyed the seed and these were replanted on June 11th. When the maize-plants were about 6 inches high the Station force thinned them out, taking care not to disturb the roots of those which were left and using the measuring line as before to control the accuracy of the spacing.

It will be seen that in this field we can study the effects of the rate of planting on two varieties of maize; one a large and the other a small variety, we can also with each of these varieties compare the effect of rate of planting both on well fertilized land, and on *heavily* fertilized land.

Mr. Webb had the crop thoroughly cultivated, following his usual farm practice.

Cutting and Stacking the Crop.

On the 20th of September the corn was cut and stacked in the way described below on all the plots except M to R which were cut on the 27th. The appearance of the crops at that time was as follows:—

Plot G, one stalk every four feet, very little lodged, husks all yellow, kernels hard.

Plot H, one stalk every two feet, very little lodged, husks yellow, rather green on the north end of the plot.

Plot I, one stalk every foot. Lodged more than H. Stalks noticeably smaller, ears almost as ripe as on H.

Plot J, two stalks to a foot. Lodged a good deal more than any of the previous-named plots, ears smaller and a little greener.

Plot K, four stalks to a foot. Stalks smaller than on J and worse lodged, ears poor and small.

Plot L, eight stalks to a foot. Not so much lodged, perhaps because nearer a grove which protects it from north to northeast winds. Greener than K, ears smaller.

The same observations apply to the corresponding plots in the other two rows.

It is evident that the stalks on the edges of each plot must be more or less affected by the crop growing on the adjacent plots. For instance the stalks on the south end of plot B are somewhat shaded by those of plot A which stand only half as thick. On

the east they are shaded by those of plot H which are planted at a like distance apart, but which are not nearly as tall and leafy. On the north lies the more closely planted plot C, but on the west side the plot is not at all shaded. To counteract as far as possible these inequalities of light the crop was harvested and weighed on only one half of each plot, and this half was the central area corresponding in shape to that of the whole plot. Each of these *inner plots* therefore had an area of *one-twentieth of an acre.*

The number of plants in each inner plot and the area of ground surface for each plant are as follows. The plants of course are not evenly distributed over this area in this experiment.

	Number of stalks on the plot.	Number of square feet of ground surface per plant.
Plots A, G, and M, One stalk in four feet	136	16
" B, H, and N, " " " two "	272	8
" C, I, and O, " " to a foot	544	4
" D, J, and P, Two stalks to "	1088	2
" E, K, and Q, Four " " "	2176	1
" F, L, and R, Eight " " "	4352	½

The method of cutting and stacking is as follows:—

1st, Establish the corner boundaries of the inner plot which is to be harvested and weighed, and mark them with stakes.

2d, Carry a stout cord around fastened to these stakes to mark off the plot for harvesting.

3d, Count the number of stools or stalks in the inner plot, note if any are missing and how many. Cut a corresponding number, just outside the inner plot and lay them inside.

4th, Draw a sample for analysis. This is done by going through the inner plot from each south corner to the diagonally opposite north corner and cutting one or more stalks from each row, till the number cut is from 8 to 10 per cent. of the total number on the plot. This makes a very large sample to prepare for analysis, but it is probably no larger than is necessary to secure accuracy. This laboratory sample is tied up in from one to four small bundles, each having a piece of red flannel attached, and a label. These bundles are carried to the north end of the plot.

5th, The men then cut the crop which is outside the inner plot, bind it in small gavels, and stack it in the space between the rows of plots. This is done under constant supervision of an officer of the Station.

6th, The crop on the inner plot, which now stands by itself without any chance for mixing with outside corn, is cut by the men and stacked in three or more stacks of the usual size which stand in line through the center of the inner plot. The laboratory sample in each case is put in the center of the northern stack on each plot.

Harvesting and Weighing.

The weather from the time of cutting to the time of husking and weighing was quite unfavorable for curing the crop having been wet or rainy most of the time.

On Oct. 30th and 31st the crop was harvested and weighed. Three joists were bolted together at one end making a tripod, each stack of maize was tightly corded around the middle, a steelyard was attached, and by a rope and pulley made fast to the bolt of the tripod, two or three men hoisted each stack so that it swung clear and it was weighed by an officer of the Station. As soon as the north stack on each plot was weighed, the laboratory sample was taken out, carried to the Station barn and immediately separated into leaves, stripped stalks, sound kernels, soft kernels, sound cobs, soft cobs and husks, and each of these parts was at once weighed and labeled.

Each plot thus furnished 7 samples, all of which were dried, cut fine when necessary, subsampled and ground for analysis, record of all weights being kept so that the analyses could be reckoned back on to the undried or field-cured crop.

After weighing the total crop, the men husked it out with special care not to overlook the imperfect ears or "nubbins." The ears were then sorted and weighed by the Station force.

This completed the field work. The extent of the laboratory work will be seen in the discussion of the results.

Our thanks are also due to Mr. Webb's foremen, Mr. Gage and Mr. Baldwin, for their interest and hearty coöperation in carrying out an experiment which necessarily interfered more or less with the regular course of their farm work.

RESULTS OF THE EXPERIMENT.

A. QUANTITY OF CROPS.

Effect of Distance of Planting on the Gross Yield.

Table II, page 17, gives the weight in pounds of field-cured crop on the several inner plots. The table shows these facts :—

1. The flint variety of maize produced on one-twentieth of an acre 426.6 pounds of field-cured crop, when the plants stood 4 feet apart; when there were twice as many plants, 2 feet apart, the yield was 100 pounds more; doubling this number of plants, gave an increase of 85 pounds; but when the number of plants was again doubled, two to a foot, the yield instead of increasing, diminished, and still more when the number of plants was again doubled and quadrupled.

2. Maize of the dent variety produced on one-twentieth of an acre 447 pounds of field-cured crop when the plants stood 4 feet apart and the yield quite steadily increased with the thickness of planting, though not by any means proportionally thereto so that the plot where the stand was thickest had the heaviest field-cured crop.

3. Where the quantity of fertilizer was doubled the yield of the dent variety was considerably increased, but the plot with plants two to a foot yielded more than the two plots which were planted closer.

Since a large and variable portion, ranging from 43 to 60 per cent. of the gross yield of the field-cured crops is water, which has no value, the true measure of production is the *dry weight* of the crop.

Effect of Distance of Planting on the Quantity of Water-free Matter in the Crop.

Table III, page 17, gives the weight in pounds of dry matter produced on the several inner plots, each containing one-twentieth of an acre.

It will be noticed that there are three plots M, N, and O [maize of the dent variety with extra phosphate] for which the dry crop is missing. The reason is that the huskers who had been set at work by the foreman on another piece of ground finished their job there, and then, in his absence, volunteered some work on the

TABLE II.—GROSS WEIGHTS OF FIELD-CURED CROPS.—POUNDS PER 1–20TH ACRE.

	One stalk in four feet. Plots G, A, and M.	One stalk in two feet. Plots H, B, and N.	One stalk to a foot. Plots I, C, and O.	Two stalks to a foot. Plots J, D, and P.	Four stalks to a foot. Plots K, E, and Q.	Eight stalks to a foot. Plots L, F, and R.
Flint Maize	426.6	524.6	**609.0**	555.8	521.0	471.6
Dent Maize	447.0	626.0	761.9	745.5	770.0	**779.0**
Flint Maize, with extra phosphate	----	----	----	----	----	624.7
Dent Maize, with extra phosphate	336.0	677.0	836.5	**958.6**	883.6	----

TABLE III.—WEIGHT OF DRY MATTER IN FIELD-CURED CROPS.—POUNDS PER 1–20TH ACRE.

Flint Maize	206.4	263.2	**344.9**	293.3	291.7	248.9
Dent Maize	178.1	302.5	367.5	**399.0**	371.8	365.5
Flint Maize, with extra phosphate	----	----	----	----	----	356.5
Dent Maize, with extra phosphate	----	----	----	470.2	395.6	----

experimental field and had husked out the crop on plots M, N, and O, laboratory sample and all, before they were discovered, thus destroying that part of the experiment.

The table shows :—

1. Maize of the flint variety produced most dry matter when the plants stood a foot apart in the row. Thicker planting as well as thinner planting decreased the yield.

2. The dent variety produced most dry matter when the plants stood two to a foot in the row. Thicker planting than this decreased the yield of dry matter. The increased weight of gross yield noticed above with the thicker stand was wholly made up of water.

3. The extra phosphate also increased in every case the dry weight of the crop.

Weights of the Separate Parts of the Water-free Maize Plant in the Total Crops.

Table IV, page 19, shows the yield in pounds of the several parts of the water-free maize plants on the different plots, each of which contains one-twentieth of an acre.

Regarding first the flint variety:—

1. The yield of sound kernels, or dry shelled corn, increased steadily with the thickness of planting up to a stand of two plants to the foot.

The yield fell off rapidly when that limit was passed and eight plants to a foot produced no sound kernels* at all. The highest yield of dry matter was from planting a foot apart. But a thicker planting in this case yielded more sound kernels. Extra phosphate produced some sound ears with the thickest planting.

2. The yield of soft kernels followed the opposite course. It was smallest where the yield of sound kernels was largest and increased as the sound kernels decreased.

3. The dry weight of leaves increased regularly with the thickness of planting and was greatest where the stand was thickest. The extra phosphate decreased the yield.

4. The dry weight of stripped stalks increased with the thickness of planting up to a stand of one plant to a foot—a distance which gave the largest yield of dry matter—and then fell off with thicker planting though the very closest planting gave nearly

* By sound kernels are meant kernels from marketable ears, as distinguished from either "nubbins" or soft ears.

TABLE IV.—TOTAL WEIGHTS OF MATTER IN THE DIFFERENT PARTS OF THE WATER-FREE CROP.
POUNDS PER 1-20th ACRE.

		Sound Kernels.*	Soft Kernels.	Leaves.	Stripped Stalks.	Husks.	Sound Cob.	Soft Cob.
Flint maize,	G, One stalk in four feet	66.45	28.57	41.05	29.11	22.90	11.53	6.86
	H, One " " two "	124.64	20.42	49.59	32.76	26.27	5.07	4.49
	I, One " to a foot	143.46	21.44	58.15	**64.88**	**26.94**	**24.94**	5.13
	J, Two stalks to a foot	**162.81**	13.62	58.78	41.03	22.90	3.29	.91
	K, Four " "	121.27	29.27	80.14	29.62	20.42	5.48	5.47
	L, Eight " "	none	**64.30**	**98.49**	63.68	9.97	none	**12.47**
Flint maize, Extra phosphate,	R, Eight stalks to a foot	60.23	55.72	79.66	125.08	16.27	9.22	10 36
Dent maize,	A, One stalk in four feet	54.84	10.56	37.38	46.09	14 32	9.42	5.45
	B, One " " two "	131.19	7.00	57.22	63.94	21.36	19.72	2.02
	C, One " to a foot	147.88	12.91	72.68	78.21	**26.61**	**25.90**	3.26
	D, Two stalks to a foot	**164.60**	15.47	88 07	95.07	23.30	9.36	3.17
	E, Four " "	49.12	36.87	116.09	131.74	20.28	8.28	9.42
	F, Eight " "	17.30	**43.00**	**138.50**	**140.32**	13.24	2.18	**11.00**
Dent maize, Extra phosphate,	M, One stalk in four feet	----	----	----	----	----	----	----
	N, One " " two "	----	----	----	----	----	----	----
	O, One " to a foot	----	----	----	----	----	----	----
	R, Two stalks to a foot	177.39	23.71	108.84	115.39	28.93	11.05	4.89
	Q, Four " "	33.89	49.06	126.60	143.95	22.41	6.55	13.10

* By sound kernels are meant kernels from marketable ears as distinguished from either "nubbins" or soft ears.

as large a yield of dry canes as any other, and the extra phosphate nearly doubled this yield.

5. The yield of husks increased and decreased with the yield of sound and soft kernels as was to be expected.

6. The yield of cobs showed irregularities which create suspicion of errors in weighing.

Regarding next the dent variety:—7. The dent variety showed nearly the same course as the flint variety in the increase and decrease of sound and soft kernels and leaves, due to rate of planting but there was a striking difference in the water-free weight of of stripped stalks. While the weight of water-free stalks of the flint variety was greatest where the plants stood one to a foot in the row, the weight of water-free stalks of the dent variety increased steadily with the thickness of stand and was greatest where the stand was thickest—eight plants to a foot.

This table supplies interesting data for a comparison of these two strikingly dissimilar varieties of Indian Corn. But as other data will appear when the chemical composition of the varieties is examined, the comparison will be reserved till all the facts gathered have been presented. See page 37.

Proportions of Kernels, Leaves, Stalks, etc. in the Water-Free Crop.

Table V, page 21, shows in per cents. what fraction or part of the total dry weight of crop on each plot consisted of sound kernels, what of leaves, stripped stalks, etc.

For instance when the plants of the flint variety stood 4 feet apart 32.1 per cent. or nearly one third of the total dry weight was contained in the kernels and 19.9 per cent. or about one-fifth in the leaves, and so on.

It appears from this table:—

1. The proportion of sound kernels of the flint variety to total water-free crop increased with thickness of planting up to a stand of two stalks to a foot and then with closer planting decreased rapidly, while the proportion of kernels of the dent variety to total crop was greatest when the stand was one stalk to two feet and the proportion decreased with thicker planting. The extra phosphate increased the proportion of sound kernels of flint maize but rather decreased it in the case of the dent variety. The larger percentage of soft kernels on plots A and G where the planting was thinnest is explained by the extraordinary suckering on those plots which produced many nubbins.

TABLE V.—PERCENTAGE IN PARTS OF THE TOTAL WATER-FREE CROP.

		Sound Kernels.	Soft Kernels.	Leaves.	Stripped Stalks.	Husks.	Sound Cob.	Soft Cob.
Flint maize,	G, One stalk in four feet	32.1	13.8	19.9	14.1	**11.61**	5.6	3.4
	H, One " " two "	47.4	7.8	18.9	12.4	9.9	1.9	1.7
	I, One " to a foot	41.6	6.2	16.8	18.8	7.9	**7.2**	1.5
	J, Two stalks to a foot	**55.5**	1.3	20.0	13.9	7.8	1.2	.3
	K, Four " "	41.6	10.0	27.4	10.2	7.0	1.9	1.9
	L, Eight " "	none	**25.9**	**39.6**	**25.6**	3.9	none	**5.0**
Flint maize, Extra phosphate,	R, Eight stalks to a foot	16.8	15.6	22.4	35.2	4.5	2.6	2.9
Dent maize,	A, One stalk in four feet	30.8	5.9	20.9	25.8	**8.2**	5.3	**3.1**
	B, One " " two "	**42.3**	2.3	19.0	21.1	7.1	6.5	.7
	C, One " to a foot	40.3	3.5	19.8	21.3	7.2	**7.0**	.9
	D, Two stalks to a foot	41.3	3.9	22.1	23.8	5.8	2.3	.8
	E, Four " "	13.3	9.9	31.2	35.5	5.4	2.2	2.5
	F, Eight " "	4.7	**11.8**	**37.9**	**38.4**	3.6	0.6	3.0
Dent maize, Extra phosphate,	M, One stalk in four feet	----	----	----	----	----	----	----
	N, One " " two "	----	----	----	----	----	----	----
	O, One " to a foot	----	----	----	----	----	----	----
	P, Two stalks to a foot	37.8	5.0	23.1	24.5	6.2	2.4	1.0
	Q, Four " "	8.6	12.4	32.0	36.4	5.7	1.6	3.3

2. The proportion of leaves to total dry crop was the inverse of that of the ears, or was largest where the proportion of sound kernels was smallest. The extra phosphate decreased the proportion of dry weight of leaves of the flint variety but increased the proportion of leaves of the dent variety.

3. The proportional yield of stripped stalks showed some irregularities, but in each variety the relative yield of canes was largest where the stand of maize was thickest. The proportion of dry weight of stalks of the dent variety increased regularly from the plot where the stand was one stalk to two feet up to the thickest stand. It was not materially changed by the addition of extra phosphate.

B. CHEMICAL COMPOSITION OF THE CROPS.

Percentage Composition of the Field-cured Crops.

Table VI, page 23, gives the chemical composition of the field-cured crops and Table VII the chemical composition of the separate parts of the crops. These tables by themselves show little in regard to the comparative quality of the crops because the water is such a large and varying quantity. They furnish the basis, however, for the subsequent calculations, and are necessary as a matter of record.

It will be seen that the dent variety contains considerably more water than the flint, as would be expected. The flint variety was more mature and drier than the other at the time of cutting.

The quantity of water in the field-cured crop is larger than usual because of the very wet weather that prevailed while the crop was field-curing in the stacks. The variations in the water-content of field-cured maize stover are remarkable. When housed after curing, it does not always continue to lose weight by drying, but may increase in weight by absorbing water from the air so as to weigh more by a quarter of its original weight late in the winter than it did in the fall. Thus Norfolk white corn grown by Mr. Webb in 1874, for fodder, when cut, September 1, contained 86 per cent. of water. When field-cured, Nov. 11, it had 27 per cent., and was then got into the barn in excellent condition. But on Feb. 8th, after much warm and damp weather it contained 54 per cent. of water. That is, five tons of maize fodder got in on the 11th of November, became eight tons in February as it lay in the barn, and this gain of three tons was wholly water absorbed from the air, the barn giving perfect shelter. (Conn. Ag. Ex. St., 1878, 64.)

Table VI.—Percentage Composition of Field-cured Crops.

		Water.	Ash.	Albuminoids. (N × 6.25).	Fiber.	Nitrogen-free Extract.	Crude Fat.
Flint Maize,	G, One stalk in four feet	**51.61**	1.98	5.42	8.03	31.29	1.67
	H, One " " two "	49.82	1.77	**5.64**	7.47	33.49	1.81
	I, One " to a foot	43.36	**2.01**	5.22	10.18	37.22	2.01
	J, Two stalks to a foot	47.22	1.89	5.07	8.03	35.73	2 06
	K, Four " "	44.02	1.97	4.60	9.96	**37.37**	**2.08**
	L, Eight " "	47.22	1.85	3.62	**12.65**	33.25	1.41
Flint Maize, Extra Phosphate,	R, Eight " "	42.93	2.17	4.18	13.04	35.95	1.73
Dent Maize,	A, One stalk in four feet	**60.17**	**1.74**	4.01	8.35	24.50	1.23
	B, One " " two "	51.68	1.59	**4.49**	9.03	31.53	1.68
	C, One " to a foot	51.78	1.59	3.85	9.32	31.84	1.62
	D, Two stalks to a foot	46.47	1.73	4.01	10.38	**35.59**	**1.82**
	E, Four " "	51.71	1.55	3.06	11.84	30.65	1.19
	F, Eight " "	53.08	1.47	2.72	**12.52**	29.19	1.02
Dent Maize, Extra Phosphate,	M, One stalk in four feet	----	----	----	----	----	----
	N, One " " two "	----	----	----	----	----	----
	O, One " to a foot	----	----	----	----	----	----
	P, Two stalks to a foot	50.95	1.66	3.83	9.73	32.23	1.60
	Q, Four " "	55.23	1.66	2.94	11.39	27.61	1.17

TABLE VII. — PERCENTAGE COMPOSITION OF THE SEPARATE PARTS OF THE CROPS, FIELD-CURED.

		Water.	Ash.	Albuminoids. (N. × 6.25)	Fiber.	Nitrogen-free extract.	Crude Fat.
	SOUND KERNELS.						
Flint maize,	G, One stalk in four feet	26.58	1.15	10.55	.86	56.78	4.08
	H, " " " two "	28.06	.92	9.61	.84	56.83	3.74
	I, " " to a foot	27.04	1.06	8.57	.85	58.39	4.09
	J, Two stalks " "	29.38	.86	8.52	.90	56.31	4.03
	K, Four " " "	25.27	1.18	5.55	.81	60.96	4.23
	L, Eight " " "						
	R,* " " " "	32.11	.62	6.19	.85	56.38	3.85
Dent maize,	A, One stalk in four feet	36.17	1.07	7.95	.95	50.29	3.57
	B, " " " two "	31.00	1.05	8.28	1.11	54.57	3.99
	C, " " to a foot	37.37	.91	6.38	.96	50.78	3.60
	D, Two stalks " "	32.40	.78	6.23	1.19	55.51	3.89
	P,* " " " "	36.63	.78	6.01	1.00	52.01	3.57
	E, Four " " "	37.85	.77	4.82	.97	52.15	3.44
	Q,* " " " "	35.97	.69	4.40	.91	54.50	3.53
	F, Eight " " "	37.17	.79	5.46	.93	52.23	3.42
	SOFT KERNELS.						
Flint,	G, One stalk in four feet	23.95	1.02	10.26	.76	59.74	4.27
	H, " " " two "	27.70	.94	9.70	.94	56.87	3.85
	I, " " to a foot	30.80	.96	9.81	.79	53.67	3.97
	J, Two stalks " "	74.80	.37	3.25	.30	19.89	1.39
	K, Four " " "	26.68	1.01	8.52	.98	58.79	4.02
	L, Eight " " "	24.94	.74	7.05	.77	62.52	3.98
	R,* " " " "	32.80	.70	6.66	.83	55.53	3.48
Dent,	A, One stalk in four feet	57.53	.91	5.44	.89	33.46	1.77
	B, " " " two "	31.21	1.20	8.56	1.03	54.06	3.94
	C, " " to a foot	34.00	1.04	8.00	1.06	52.24	3.66
	D, Two stalks " "	37.36	.97	7.30	1.10	50.05	3.22
	P,* " " " "	40.16	.83	6.78	1.08	47.72	3.43
	E, Four " " "	37.20	.73	6.27	.93	51.48	3.39
	Q,* " " " "	37.89	.80	6.23	1.10	50.45	3.53
	F, Eight " " "	36.12	.73	5.52	.97	52.90	3.76
	LEAVES.						
Flint,	G, One stalk in four feet	39.92	5.55	6.29	17.39	29.54	1.31
	H, " " " two "	36.16	5.51	6.44	19.18	31.48	1.23
	I, " " to a foot	42.80	5.17	4.96	17.74	28.30	1.03
	J, Two stalks " "	35.26	5.81	5.31	20.28	32.22	1.16
	K, Four " " "	22.53	5.73	5.41	27.40	37.39	1.54
	L, Eight " " "	28.48	4.28	4.65	22.54	38.75	1.30
	R,* " " " "	32.89	5.58	5.18	20.55	34.40	1.40
Dent,	A, One stalk in four feet	33.64	6.11	8.28	18.72	31.74	1.52
	B, " " " two "	26.70	5.52	7.36	20.95	38.15	1.32
	C, " " to a foot	18.19	6.72	7.88	24.16	41.43	1.62
	D, Two stalks " "	26.23	6.04	6.41	21.86	38.12	1.34
	P,* " " " "	27.79	5.82	6.48	21.72	36.90	1.29
	E, Four " " "	24.88	4.81	5.89	22.79	40.26	1.37
	Q,* " " " "	23.14	5.53	6.10	23.33	40.36	1.54
	F, Eight " " "	32.19	3.67	4.45	22.06	36.44	1.19

* Extra fertilizer.

TABLE VII—CONTINUED.

		Water.	Ash.	Albuminoids. (N. × 6.25)	Fiber.	Nitrogen-free extract.	Crude Fat.
	STRIPPED STALKS.						
Flint.	G, One stalk in four feet	76.14	1.55	2.84	6.88	12.13	.46
	H, " " " two "	74.93	1.22	2.38	8.35	12.73	.39
	I, " " to a foot	59.66	1.88	2.83	14.02	20.75	.86
	J, Two stalks " "	67.28	1.67	1.76	11.89	16.97	.43
	K, Four " " "	78.53	.86	1.15	7.96	11.18	.32
	L, Eight " " "	70.32	.81	1.83	9.47	17.00	.57
	R,* " " " "	51.33	1.95	2.98	16.80	25.98	.98
Dent.	A, One stalk in four feet	76.25	1.22	1.90	8.51	11.70	.42
	B, " " " two "	73.98	.99	1.68	9.64	13.27	.44
	C, " " to a foot	68.47	1.05	1.53	11.97	16.48	.50
	D, Two stalks " "	61.06	1.07	1.62	14.89	20.84	.52
	P,* " " " "	67.69	.94	1.49	12.02	17.42	.44
	E, Four " " "	66.47	.69	1.38	10.86	20.14	.46
	Q,* " " " "	67.47	.84	1.53	10.84	18.73	.59
	F, Eight " " "	66.70	.63	1.37	10.25	20.63	.42
	HUSKS.						
Flint.	G, One stalk in four feet	48.46	2.27	3.22	16.20	29.06	.79
	H, " " " two "	58.47	2.26	2.90	13.03	22.69	.65
	I, " " to a foot	53.94	2.03	2.44	14.71	26.23	.65
	J, Two stalks " "	51 93	2.26	1.95	16.18	26.98	.70
	K, Four " " "	33.64	2.07	2.60	22.69	38.18	.83
	L, Eight " " "	26.71	1.86	3.22	23.63	43.57	1.01
	R,* " " " "	45.72	1.84	2 54	17.81	31.36	.73
Dent.	A, One stalk in four feet	63.59	1.47	2.06	11.96	20.37	.55
	B, " " " two "	53 83	1.76	2.28	15.08	26.36	.69
	C, " " to a foot	50.98	1.54	2.12	15.96	28.72	.68
	D, Two stalks " "	48.44	1.68	2.42	16.61	30.05	.80
	P,* " " " "	52.93	1.73	2.59	14.92	27.03	.81
	E, Four " " "	48.70	1.37	2.84	15.18	31.14	.77
	Q,* " " " "	76.60	.61	1.28	6.79	14.26	.46
	F, Eight " " "	48.56	1.29	2.73	15.15	31.52	.75
	SOUND COBS.						
Flint.	G, One stalk in four feet	48.61	.75	1.10	17.89	31.43	.22
	H, " " " two "	88.32	.12	.26	4.17	7.09	.04
	I, " " to a foot	49.09	.56	1.28	18.61	30.28	.18
	J, Two stalks " "	92.31	.09	.16	2.77	4.58	.03
	K, Four " " "	85.38	.19	.36	5.25	8.75	.07
	L, Eight " " "						
	R,* " " " "	60.38	.53	.81	14.70	23.42	.16
Dent.	A, One stalk in four feet	65.73	.45	1.06	10.88	21.69	.20
	B, " " " two "	61.59	.42	.80	13.01	24.00	.18
	C, " " to a foot	61.94	.41	.82	12.40	24.20	.23
	D, Two stalks " "	84.66	.14	.28	5.29	9.58	.05
	P,* " " " "	80.19	.24	.47	6.48	12.55	.07
	E, Four " " "	59.89	.51	.88	13.80	24.73	.19
	Q,* " " " "	51.45	.60	1.14	15.94	30.71	.16
	F, Eight " " "	66.25	.39	.73	11.68	20.75	.20

* Extra fertilizer.

TABLE VII—CONTINUED.

		Water.	Ash.	Albuminoids. (N. × 6.25)	Fiber.	Nitrogen-free extract.	Crude Fat.
	SOFT COBS.						
Flint.	G, One stalk in four feet...	38.00	1.37	2.92	20.87	36.44	.40
	H, " " " two " ...	43.96	.97	2.15	19.62	32.96	.35
	I, " " to a foot	55.25	.92	2.19	15.62	25.71	.31
	J, Two stalks " "	76.85	.43	.78	8.12	13.63	.19
	K, Four " " "	40.35	1.10	2.28	20.75	35.17	.35
	L, Eight " " "	37.72	1.09	1.32	22.10	37.43	.34
	R,* " " " "	60.38	.53	.81	14.70	23.42	.16
Dent.	A, One stalk in four feet...	71.28	.64	1.49	8.22	18.14	.23
	B, " " " two " ...	53.16	.78	2.47	14.57	28.72	.30
	C, " " to a foot	52.86	.67	1.78	14.71	29 76	.22
	D, Two stalks " "	57.92	.69	1.42	13.65	25.94	.38
	P,* " " " "	64.90	.62	1.38	11.34	21.51	.26
	E, Four " " "	61.76	.66	.89	12.95	23.42	.32
	Q,* " " " "	62.38	.60	1.46	12.20	23.16	.20
	F, Eight " " "	58.24	.66	1.39	14.17	25.27	.27

* Extra phosphate.

PERCENTAGE COMPOSITION OF THE DRY MATTER IN THE FIELD-CURED CROPS.

Table VIII, page 27, gives the chemical composition of the dry-matter harvested from each plot. It does not indicate the total yield of the chemical ingredients, but only the relative quantity of each. To illustrate, take the first horizontal column of the table. 4.08 per cent. or 4.08 pounds in every hundred of the dry matter raised on the plot which had one stalk in four feet were ash or mineral matter, 11.20 per cent. or pounds per hundred were albuminoids, and so on.

The table brings out the following facts:

Ash.—The ash of the flint variety shows no very striking changes due to distance of planting. The thinnest planted maize, Plot A, had the largest percentage of ash, but on all the other plots the percentage was practically the same.

The per cent. of ash of the dent variety decreased as the plants stood closer, and there is a difference of 1.2 per cent. in the ash between the thickest and thinnest planted plots. Extra phosphate increased the per cent. of ash of both varieties of maize.

TABLE VIII.—PERCENTAGE COMPOSITION OF THE DRY MATTER IN THE FIELD-CURED CROPS.

		Ash.	Albuminoids. (N. × 6.25)	Fiber.	Nitrogen-free Extract.	Fat.
Flint maize,	G, One stalk in four feet	**4.08**	11.20	16.60	64.68	3.44
	H, One " " two "	3.53	**11.25**	14.88	66.74	3.60
	I, One " to a foot	3.55	9.21	17.98	65.73	3.53
	J, Two stalks to a foot	3.58	9.60	15.23	**67.70**	**3.89**
	K, Four " "	3.52	8.22	17.79	66.77	3.70
	L, Eight " "	3.51	6.88	**23.97**	63.00	2.66
Flint maize, Extra phosphate,	R, Eight " "	3.80	7.32	22.57	63.15	3.16
Dent maize,	A, One stalk in four feet	**4.28**	**10.05**	20.97	61.51	3.09
	B, One " " two "	3.28	9.28	18.69	65.28	**3.47**
	C, One " to a foot	3.29	7.99	19.33	66.03	3.36
	D, Two stalks to a foot	3.23	7.49	19.40	**66.48**	3.40
	E, Four " "	3.23	6.33	24.54	63.47	2.43
	F, Eight " "	3.12	5.80	**26.68**	62.23	2.17
Dent maize, Extra phosphate,	M, One stalk in four feet	----	----	----	----	----
	N, One " " two "	----	----	----	----	----
	O, One " to a foot	----	----	----	----	----
	P, Two stalks to a foot	3.39	7.80	19.83	65.71	3.27
	Q, Four " "	3.71	6.56	25.46	61.66	2.61

Albuminoids.—The albuminoids of both varieties in general followed the same course as the ash or mineral matter. The dry matter from the plots where the stand was thinnest had the largest per cent. of albuminoids, and this percentage quite regularly decreased and was least in the dry matter of the most thickly planted plots. The difference is very striking: Thus the percentage of albuminoids in the dry matter from Plot G, where flint maize stood one stalk in four feet, was 11.2, but where it stood eight stalks to a foot (Plot L) the percentage was but a little more than one-half that, 6.88.

Fiber.—The per cent. of fiber on Plots G and A, one plant in four feet, was larger than on some of the following plots, but with exception of those plots and Plot J, the per cent. of fiber increased with the thickness of planting and was largest where the planting was thickest.

The extra phosphate did not sensibly affect the per cent. of fiber.

Nitrogen-free Extract.—The per cent. of nitrogen-free extract was largest where the stand was two or four stalks to a foot, Plots J, K and D, and decreased where the stand was either thicker or thinner.

Fat.—The per cent. of fat did not seem to be particularly affected by the stand of the crop, though it was least where the stand was thickest.

To recapitulate: the per cent. of ash and albuminoids in the water-free crop was greatest where the stand of maize was thinnest and decreased regularly as the stand was thicker, being least where the plants stood closest. This difference was quite small in the case of ash, but very large in the case of albuminoids.

The per cent. of fiber was largest where the stand was thickest and probably decreased pretty regularly as the stand of maize was thinned. There was the largest percentage of nitrogen-free extract where the stand of maize was neither very close nor very thin, but from two to four stalks to a foot.

We are now in position to ascertain the

Total Quantities of Water, Ash, Albuminoids, etc. harvested from Each Plot.

These have been calculated from the data already presented and are given in Table IX, page 29, which plainly shows the real value of the crops. Study of the results with *the flint variety of maize* shows:

TABLE IX.—TOTAL PRODUCTION OF WATER, ASH, ALBUMINOIDS, ETC. ON EACH PLOT.

POUNDS PER 1-20TH, ACRE.

		Field-cured.	Dry matter.	Water.	Ash.	Albuminoids. (N. × 6.25)	Fiber.	Nitrogen-free extract.	Fat.
Flint maize,	G, One stalk in four feet	426.59	206.43	220.16	8.42	23.12	34.25	133.53	7.11
	H, " " " two "	524.55	263.24	261.31	9.28	29.61	39.17	175.68	9.50
	I, " " to a foot	**609.00**	**344.94**	**264.06**	**12.25**	**31.79**	**62.00**	**226.69**	**12.21**
	J, Two stalks " "	555.79	293.34	262 45	10.51	28.17	44 65	198.58	11.43
	K, Four " " "	521.00	291.67	229.33	10.25	23.98	51.89	194.74	10.81
	L, Eight " " "	471.58	248.91	222.67	8.73	17.08	59.66	156.81	6.63
Flint maize, Extra phosphate,	R, Eight stalks to a foot	624.72	356.54	268.18	13.56	26.10	81.50	224.57	10.81
Dent maize,	A, One stalk in four feet	447.00	178.06	268.94	7.79	17.91	37.34	109.53	5.49
	B, " " " two "	626.00	302.45	323.55	9.93	28.08	56.52	197.41	10.51
	C, " " to a foot	761.91	367.45	394.46	12.09	29.36	71.03	242.61	12.36
	D, Two stalks " "	745.50	**399.04**	346.46	**12.87**	**29.92**	77.39	**265.30**	**13.56**
	E, Four " " "	770.00	371.80	**398.20**	11.99	23.53	91.24	235.97	9.07
	F, Eight " " "	**779.00**	365.54	413.46	11.40	21.20	**97.54**	227.46	7.94
Dent maize, Extra phosphate,	M, One stalk in four feet	336.00	----	----	----	----	----	----	----
	N, " " " two "	677 00	----	----	----	----	----	----	----
	O, " " to a foot	838.50	----	----	----	----	----	----	----
	P, Two stalks " "	958.55	471.20	488.35	15.93	36.66	93.26	308.98	15.37
	Q, Four " " "	883.62	395.56	488.06	14.67	25 96	100.65	243.94	10.34

1. The quantity of ash or mineral matter, of albuminoids, of fiber, of nitrogen-free extract and of fat, every valuable ingredient in the crop, was largest when the plants stood one to a foot, plot I.

2. A stand of two to a foot, plot J, produced very little more of any ingredient than a stand of one to two feet, plot H. The single exception to this is nitrogen-free extract. Plot J produced 23 pounds more of this substance than plot H.

Examining the results with *the dent variety of maize* it appears:

3. The quantity of ash or mineral matter, of albuminoids, of nitrogen-free extract and of fat was largest when the plants stood two to a foot, plot D, but the largest quantity of fiber was produced by the thickest planting, eight plants to a foot, plot F.

4. A stand of one plant to a foot produced more of every ingredient except fiber than a stand of four to a foot, so the rate which would have given the maximum yield was either two to a foot or between one and two to a foot.

5. In every case the extra phosphate produced an increase of all the ingredients of the crop.

Comparative Development of the Individual Maize Plant.

We have seen that the largest total yields both of shelled corn and of stover have been on plots where the plants stood one to a foot or two to a foot in the row. Standing at these distances there were 544 and 1088 plants on the plots respectively. But plots A, G and M contained only 136 plants. While the total yield on these last-named plots was less, it is interesting and important to know how the production of the *single plants* compared with that of plants standing closer together. This question has an important bearing on the raising of corn for seed.

Table X, page 31, gives the total water-free weight of the different parts of 1000 maize plants grown at the different distances named.

Examination of these figures shows that the individual plants which stood furthest apart, and had the most light and the most soil at their disposal attained the greatest development in all their parts. It also shows that the yield per plant quite regularly decreased as the stand became thicker though not by any means proportionally to the closeness of the stand. To

TABLE X.—COMPARATIVE DEVELOPMENT OF THE MAIZE PLANT.

Weight in pounds of Water-free product of 1000 *Seed Kernels, for each of the distances named.*

		Field-cured weight.	Water-free weight.	Sound kernels.	Soft kernels.	Leaves.	Canes.	Husks and cobs.
Flint maize,	G, One stalk in four feet	**3136.8**	**1517.7**	**488.3**	**210.1**	**301.8**	**214.0**	**303.6**
	H, " " two "	1928.4	967.5	458.2	75.1	182.3	120.4	131.7
	I, " to a foot	1120.6	634.6	264.0	39.5	107.0	119.4	104.9
	J, Two stalks " "	510.8	269.5	149.6	3.3	54.0	37.7	24 9
	K, Four " " "	239.6	134.1	55.7	12.4	36.8	13.6	14.4
	L, Eight " " "	108.4	57.2	none	14.7	22.6	14.6	5.1
Flint maize, Extra phosphate,	R, Eight stalks to a foot	143.6	81.1	13.8	12.8	18.3	28.7	8.2
Dent maize,	A, One stalk in four feet	**3286.8**	**1309.6**	403.2	**77.6**	**274.9**	**338.9**	**214.6**
	B, " " two "	2301.1	1112.0	**482.3**	25.7	210.3	235.1	158.4
	C, " to a foot	1401.9	676.2	272.1	23.8	133.7	143.9	102.6
	D, Two stalks " "	685.1	366.7	151.3	14.2	80.9	87.4	32.8
	E, Four " " "	344.2	171.0	22 6	17.0	53.4	60.6	17.4
	F, Eight " " "	179.1	84.0	4.0	9.9	31.9	32.2	6 0
Dent maize, Extra phosphate,	M, One stalk in four feet	2470.6	....	....	....	....	....	....
	N, " " two "	2488.6	....	....	....	....	....	....
	O, " to a foot	1537.5	....	....	....	....	....	....
	P, Two stalks " "	881.0	432.1	163.0	21.8	100.0	106.0	41.2
	Q, Four " " "	406.4	182.0	15.6	22.6	58.2	66.2	19.3

illustrate:—Where the stalks of dent maize stood eight to a foot 1000 plants produced 84 pounds of dry matter. When the distance between the plants was doubled, 4 stalks to a foot, the yield per 1000 plants was also doubled, 171 pounds. When the distance between plants was again doubled, 2 stalks to a foot, the yield was again more than doubled, 366.7 pounds. But doubling the distance again, having 1 stalk to a foot, did not quite double the yield per 1000 plants, it was only 1.8 times as large. Again doubling the distance, 1 stalk in two feet, increased the yield per 1000 plants 1.6 times and another doubling of the distance, leaving only one plant in four feet increased the yield of 1000 plants only 1.2 times. Evidently a larger yield per 1000 plants could not be expected from planting stalks of this dent variety more than 4 feet apart each way. That is, under the conditions of this experiment the individual dent maize plant about reached its maximum development when the single plants stood at a distance from each other of four feet.

It would seem as if the smaller flint maize ought to attain its maximum development with a smaller area of soil, i. e. with closer planting than the dent variety, but this has not been the case in this experiment. With each doubling of the distance between the plants the proportional increase in the yield per 1000 maize plants was as follows:—

	8 plants to a foot.	4 plants to a foot.	2 plants to a foot.	1 plant to a foot.	1 plant in 2 feet.	1 plant in 4 feet.
Distance between plants	1½ ins.	3 ins.	6 ins.	12 ins.	24 ins.	48 ins.
Dent variety.....	1	2	2.1	1.8	1.6	1.2
Flint variety	1	2.3	2.0	2.4	1.5	1.6

Which means that when the distance between plants in the row was doubled, from 1½ inches to 3 inches, the yield of a thousand dent maize plants was two times as large and of flint 2.3 times as large. So when the distance was doubled from twenty-four to forty-eight inches, while the yield of 1000 plants of the dent variety was 1.2 times as large at forty-eight as at twenty-four inches the yield of the flint was 1.6 times as large; from which it is fair to conclude that a greater distance between plants would produce almost no increase in yield of the individual dent maize plant but probably would produce further increase in that of the flint variety.

Table XI, page 33, shows the quantity of ash, albuminoids, fiber, nitrogen-free extract and fat, harvested from 1,000 maize

TABLE XI.—COMPARATIVE DEVELOPMENT OF THE MAIZE PLANT.

Pounds of Ash, Albuminoids, etc., in 1,000 plants, for each of the distances named.

		Dry Weight.	Ash.	Albuminoids. (N. × 6.25)	Fiber.	Nitrogen-free Extract.	Fat.
Flint maize,	G, One stalk in four feet	**1517.7**	**61.97**	**169.76**	**251.64**	**982.90**	**52.33**
	H, One " " two "	967.5	34.15	108.56	143.73	645.70	34.96
	I, One " to a foot	634.6	22.54	58.49	114.00	417.10	22.47
	J, Two stalks " "	269.5	9.66	25.85	41.08	182.39	10.52
	K, Four " " "	134.1	4.71	11.03	23.85	89.50	4.97
	L, Eight " " "	57.2	2.01	3.92	13.72	36.02	1.53
Flint maize, Extra phosphate,	Eight " " "	81.1	3.11	6.00	18.45	51.05	2.49
Dent maize,	A, One stalk in four feet	**1309.6**	**57.26**	**131.79**	**274.65**	**805.55**	**40.35**
	B, One " " two "	1112.0	36.54	103.22	207.49	726.07	38.68
	C, One " to a foot	676.2	22.24	45.98	130.69	454.55	22.74
	D, Two stalks " "	367.7	11.84	27.53	71.20	244.48	12.47
	E, Four " " "	171.0	5.51	10.82	41.97	108.53	4.17
	F, Eight " " "	84.0	2.62	4.88	22.43	52.24	1.83
Dent maize, Extra phosphate,	M, One stalk in four feet	----	----	----	----	----	----
	N, One " " two "	----	----	----	----	----	----
	O, One " to a foot	----	----	----	----	----	----
	P, Two stalks " "	432.1	14.65	33.70	85.64	284.00	14.11
	Q, Four " " "	182 0	6.74	11.94	46.30	112.26	4.76

plants when planted at the different distances named. It shows that not only the total dry weight per plant regularly increases with increased distance of planting, but that the weight of each food-ingredient in it increased at a similar rate. It is a striking fact that the percentage of albuminoids in the dry matter *from the individual maize plant* regularly increased as the stand of plants was thinner. The following table gives the percentage composition of the water-free product of plants growing on the plots named. See also page 27.

TABLE XII.—PERCENTAGE COMPOSITION OF SINGLE PLANTS ON PLOTS G TO L.

	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
G, One stalk in four feet..	**4.08**	11.20	16.60	64.68	3.44
H, " " " two " ..	3.53	**11.25**	14.88	66.74	3.60
I, " " to a foot	3.55	9.21	17.98	65.73	3.53
J, Two stalks to a foot....	3.58	9.60	15.23	**67.70**	**3.89**
K, Four " "	3.52	8.22	17.79	66.77	3.70
L, Eight " "	3.51	6.88	**23.97**	63.00	2.66

The percentages of all the other ingredients showed no very decided changes except on Plot L. But the percentage of albuminoids regularly and rapidly diminished from Plot G where the plants were four feet apart each way to Plot L where they stood eight to a foot in rows four feet apart.

THE QUANTITIES OF NITROGEN, PHOSPHORIC ACID AND POTASH TAKEN FROM THE LAND BY THE CROPS.

Table XIII gives the pounds *per acre* of nitrogen, phosphoric acid and potash taken from the land by the crops. It appears that the quantities of these elements removed are largest where the crops are largest, as was to be expected. The average quantities removed for those rates of planting which are nearest to ordinary farm practice—drills four feet apart and stalks one or two to a foot in the drill—are given in Table XIV, and for comparison are also given the quantities of nitrogen, phosphoric acid and potash in a crop of the same variety of flint maize raised in 1887, by Mr. Bartholomew at Putnam. Mr. Bartholomew's corn was planted in hills 3½ feet apart each way and five stalks in a hill. The actual yield was 4972 pounds of dry matter per acre, but the ingredients named are reckoned to a yield of 6382 pounds for comparison with Mr. Webb's crop.

TABLE XIII.—POUNDS OF NITROGEN, PHOSPHORIC ACID AND POTASH CONTAINED IN THE CROPS PER ACRE.

		Nitrogen. Pounds.	Phosphoric Acid. Pounds.	Potash. Pounds.
Flint maize,	G, One stalk in four feet	74.0	27.6	55.1
	H, " " " two "	94.8	42.6	42.9
	I, " " to a foot	**101.7**	**47.1**	**60.8**
	J, Two stalks " "	90.1	43.1	48.4
	K, Four " " "	76.7	36.9	30.2
	L, Eight " " "	54.7	26.1	31.7
Flint maize, Extra phosphate,	R, Eight stalks to a foot	83.5	41.6	66.1
Dent maize,	A, One stalk in four feet	57.3	21.2	49.9
	B, " " " two "	89.9	36.9	48.6
	C, " " to a foot	94.0	38.5	48.5
	D, Two stalks " "	**95 7**	**40.2**	**51.7**
	E, Four " " "	75.3	34.1	41.5
	F, Eight " " "	67.8	27.2	34.7
Dent maize, Extra phosphate,	P, Two stalks to a foot	117.3	53.5	78.9
	Q, Four " " "	83.1	39.0	54.8

TABLE XIV.—AVERAGE QUANTITIES OF NITROGEN, PHOSPHORIC ACID AND POTASH REMOVED IN THE CORN CROP PER ACRE.

	Mr. Webb's Crop, 1888.		Mr. Bartholomew's, 1887.
	Dent Corn.	Flint Corn.	Flint Corn.
Nitrogen	94.8	95.9	94.1
Phosphoric Acid	39.4	45.1	29.4
Potash	50.2	54.6	92.7
Total Water-free crop	7665	6382	6382

It is seen that the quantity of nitrogen removed is practically the same in all cases and that Mr. Bartholmew's crop of flint corn removed much more potash and much less phosphoric acid than Mr. Webb's. A partial explanation of this may lie in the fact that Mr. Bartholomew's land is relatively poor in available phosphoric acid. Though the flint maize yielded less, its demands on the soil were slightly larger than those of the dent for the three ingredients, nitrogen, phosphoric acid and potash. Pound for pound, a crop of flint corn takes very considerably more of them than does dent corn, but this extra demand was fully repaid in the more concentrated nature of the feed produced by the flint variety.

The Effect of Rate of Planting as Modified by Manuring.

Wollny has shown in experiments with beets, potatoes and peas that on land which was well manured and rich in plant-food, the maximum crop was produced with a thinner planting than was required on poorer land, or in other words, the richer the land the thinner may be the seeding. He calls attention to the popular notion that fresh stable manure makes grain lodge and shows that the lodging results from too thick seeding. A rate of seeding which is just right for poor land is altogether too thick for rich land; for here the plants grow more vigorously, and therefore need more room than on poor land. When crowded they shade each other, become watery, loose-textured, and break down or lodge under a strong wind, and so it may happen that a well-manured piece of ground under experiment will give actually less crop than an unmanured piece of the same size planted in the same way. The action of any fertilizer can only be truly ascertained when the plants to which it is applied have room for unhindered development. This is a point which should be specially regarded in field-experiments with fertilizers.

Now to apply this to our corn experiment. The land was in good heart to begin with. The plots from A to L, as already explained, had an ammoniated superphosphate applied to them in the spring at the rate of 1,000 pounds to the acre, and Plots M to R had double that quantity. This last would be regarded as an excessive quantity perhaps, though it was all applied broadcast.

Of the plots which had 1,000 pounds per acre the largest yield of water-free crop of the dent variety was on Plot D, two stalks to a foot. On the plots which received 2,000 pounds per acre the largest gross yield was on Plot P, also two stalks to a foot. Unfortunately we could not ascertain the water-free weights on three of the plots, but the water-free crop on P was larger than on the next thicker planted, Q.

In every case the yield with 2,000 pounds of superphosphate to the acre was larger than that on the corresponding plot with 1,000 pounds. This last holds also for the one plot of flint maize which had a double quantity of phosphate. These facts indicate, while they do not absolutely prove that the maximum crop was produced by about the same rate of planting—two stalks to a foot in the case of dent corn—whether the land had 1,000 or 2,000 pounds of phosphate per acre.

If we had planted plots showing smaller differences of distance, say one stalk to a foot, one to ten inches, one to eight inches, and one to six inches, we might then have found a difference in the rate of planting which yielded the maximum crop, between the the sets of plots that had 1,000 pounds and those that had 2,000 pounds per acre.

The extra phosphate on each plot, without exception, not only increased the total yield over the corresponding plot which had half the quantity of phosphate, but also increased the yield of each food-ingredient of the crop. It also slightly increased the percentage of albuminoids in the water-free crop. It also increased the development of the individual corn plant as shown in Tables X and XI. We have no accurate data for calculating the money gain or loss caused by applying the extra phosphate. The best comparison we can make is between Plots D and P, both being planted alike, but P having extra phosphate.

	D. *Pounds. Per Acre.*	P. *Pounds.*	Increase in per cent.
Total Water-free crop,	7980	9404	17.8
Sound shelled corn, water-free,	3292	3547.8	7.7

The gain of sound shelled corn amounts to about 5 bushels per acre [with 14 per cent. of water] and of field-cured stover to about 1670 pounds [with 30 per cent. of water.] Evidently the extra phosphate did not pay here, nor was it to be expected that it would. The quantity used was made excessive in order to bring out if possible the effects of a heavy application of fertilizer on the relative yield of the plots having a different rate of planting.

Our experiment only shows that when the land was in good condition to start with and had besides a liberal application of superphosphate, a distance of planting which produced a maximum yield, would also produce the maximum yield when the quantity of superphosphate was doubled.

It is possible that if the land had received no phosphate at all, a thicker rate of planting than two stalks to a foot or one stalk to a foot would have given the maximum yield.

Comparison of the Flint and Dent Varieties of Maize.

A. Difference in the Relative Effects of Distance of Planting.

We have seen that in this experiment a certain rate of planting produced a maximum crop, while both a thicker and a thinner rate of planting diminished the yield.

With a distance of 4 feet between rows the dent variety produced the largest water-free crop when the stalks stood two to a foot in the row, or 21,760 stalks to the acre. When there were four to a foot, or 43,520 stalks per acre, the crop was scarcely larger than when there were only one quarter of that number, i. e. one to the foot or 10,880 per acre. 87,040 stalks per acre gave one-twelfth less crop than one quarter of that number, 21,760. When the land was more highly fertilized, having a ton of nitrogenous superphosphate per acre, instead of half a ton the result was the same; i. e. two stalks to a foot in the rows gave the largest crop.

The yields of water-free ears and stover of the dent variety were as follows:—

TABLE XV. DENT MAIZE.

	Ears.	Stover.	Total Crop.
One stalk in four feet,	80.3	97.8	178.1
" " " two "	159.9	142.6	302.5
" " to a foot,	190.0	177.5	367.5
Two stalks " "	**192.6**	206.4	**399.0**
" " " " *	217.0	253.2	470.2
Four " " "	103.7	268.1	371.8
" " " " *	102.6	293.0	395.6
Eight " " "	73.5	**292.0**	365.5

* With extra phosphate.

From this it appears that the quantity of stover regularly increased as the planting was made closer, but not the total crop or the quantity of ears.

Moreover, it appears from Table IX that the largest quantities of ash or mineral matter, of albuminoids, fat, and nitrogen-free extract [starch, sugar, gum and the like] were harvested from the plot which was planted at the rate of two stalks to a foot while the plots which were thicker planted yielded more fiber only.

That is the total water-free crop of dent maize was largest and the total quantity of each food ingredient except fiber was greatest on the plot where the rate of planting was two stalks to a foot in the row.

Let us now turn to the flint variety of maize. Table III shows that with a distance of four feet between rows, the flint variety produced the largest water-free crop when the plants stood *a foot apart* in the row,—while the maximum crop of the dent variety was produced by a closer planting, i. e. *two stalks to a foot.*

10,880 stalks to the acre of flint maize gave the maximum yield, while twice that number or 21,760 stalks to the acre gave the maximum yield of dent maize.

The yields of water-free ears and stover of the flint variety were as follows :—

TABLE XVI. FLINT MAIZE.

	Ears.	Stover.	Total Crop.
One stalk in four feet,	113.4	93.0	206.4
One " " two "	154.6	108.6	263.2
One " to a foot,	**195.0**	149.9	**344.9**
Two stalks " "	170.6	122.7	293.3
Four " " "	161.5	130.2	291.7
Eight " " "	76.8	**172.1**	248.9
" " " " *	135.5	221.0	356.5

* With extra phosphate.

One stalk to a foot produced a larger yield of stover likewise than any other rate of planting except the closest, eight to a foot.

While the total weight of ears was largest where the rate of planting was one stalk to a foot, the most sound kernels were harvested from thicker planting.

Table IX, shows that the largest quantities of each food-ingredient in the flint maize were also harvested from the plot where the stalks stood *one to a foot*, while in case of the dent variety, *two stalks to a foot* gave the largest yield of these ingredients.

These differences between the flint and dent varieties are worth notice. Here are two varieties of maize extremely unlike in their appearance. The dent is a very large kind, standing from two and a half to three feet taller than the flint variety, with much larger and heavier stalks, larger and heavier leaves, longer and larger ears, and having the reputation of yielding much more per acre. The flint variety is very much smaller, small even for a flint. It would seem as if the dent would make larger demands on the mineral matters and water of the soil, and on the light and air than the flint variety, and therefore would not yield the largest possible crop with a rate of planting which would be best for the small flint variety, but would need to be planted much thinner. So if a rate of one plant to a foot gave the maximum crop of the flint variety we should expect a greater distance, say

one stalk in 14, 18, or 24 inches, would give the largest crop of dent maize. But the reverse appears to be the case. Under the conditions of this experiment at least, the dent variety required a *closer* planting than the flint to get the highest yield.

This difference, we believe, is to be explained by differences in the nature of the variety which have been induced by selection of seed and method of culture.

Mr. Webb has raised this White Edge Dent for fifteen years or more and has planted it in rows four feet apart with stalks about one to a foot—rather closer than this of late years—his object being not to produce the most and best ears but rather to get the most feed and to feed the whole crop, ears and stover cut up together, to his cows. That is, he has grown his corn close and has carefully selected his seed from ears that did best *when grown in that way.*

Mr. Bartholomew has raised the Rhode Island White Cap and selected the seed with equal care for a long time. He aims rather for the largest crop of sound, perfectly developed ears, less attention being given to the stover. He usually plants in hills, at a wider distance than Mr. Webb. In consequence, his variety is more prolific of ears, which are small, but very firm and perfect. It would seem then that the fact which we have noted that the large dent maize produced its maximum crop when the stand was closer than that which gave the maximum yield of the smaller flint is to be partly or wholly explained by differences inherent in the variety which are more potent in determining the requirements of the crop as to light and area of soil than the physical difference in size.

B. Differences of Yield between the Dent and Flint Varieties under the same Conditions of Planting.

In Table XVII a comparison is made of the average total yields of flint and dent maize on the two plots where the rate of planting most nearly corresponds with usual farm practice, that is, two plants to a foot, and one to a foot, respectively, in rows four feet apart. The yield is calculated to the acre. All the conditions of growth were as nearly alike as it is possible to make them in the case of the two varieties.

TABLE XVII.—YIELD OF DENT AND FLINT MAIZE PER ACRE.

	Flint variety.	Dent variety.
Total crop	11648.0	15074.0
Water-free crop	6382.8	7665.0
Sound kernels	3062.7	3124.9
Soft kernels	250.6	283.8
Leaves	1169.3	1607.5
Stripped stalks	1059.1	1732.8
Husks	498.4	499.1
Sound cob	282.3	352.6
Soft cob	60.4	64.3

If we call the yield of the flint variety 100 in each case the yields of the dent will stand as follows:

	Flint.	Dent.
Total dry matter	100	120
Sound kernels	100	102
Soft "	100	113
Total "	100	103
Leaves	100	138
Stripped stalks	100	163
Husks	100	101
Sound cobs	100	125
Soft cobs	100	106

The above figures show:

1. The dent variety yielded twenty per cent., or one-fifth more of water-free crop than the flint.

2. The yield of sound shelled corn and of total shelled corn of the dent was only slightly larger than of the flint.

3. The increased yield of crop in the case of the dent variety was large in leaves, but chiefly in stripped stalks.

Table V shows that on the plots above named, where the rate of planting agrees best with common farm practice, the average yield of sound ears of the flint variety was 52.8 per cent. of the whole crop, while of the dent variety it was 45.5 per cent., and that the ratio of cob to shelled corn was 1 to 11.6 in the flint and 1 to 8.8 in the dent variety. That is, the dent had a larger relative quantity of cob than the flint.

C. Differences in Chemical Composition between the Dent and Flint Varieties.

From Table IX is calculated the average chemical composition of the water-free crops of flint and dent, including only the

plots named above, and from other data is calculated the average composition of the water-free sound kernels:

TABLE XVIII.—COMPOSITION OF THE WATER-FREE CROP AND OF THE SOUND KERNELS OF THE FLINT AND DENT VARIETIES.

	Water-free Crop.		Sound Kernels.	
	Flint.	Dent.	Flint.	Dent.
Ash	3.86	3.26	1.33	1.42
Albuminoids	9.41	7.74	11.93	9.71
Fiber	16.60	19.36	1.20	1.66
Nitrogen-free extract	66.72	66.26	79.88	81.46
Fat	3.71	3.38	5.66	5.75
	100.00	100.00	100.00	100.00

From Table VI it appears that the field-cured crops of flint corn had on the average 47.2 per cent. of water, while the dent variety had 52.5 per cent. This is due to the fact that the flint ripened earlier and was drier when cut.

Regarding next the *chemical composition* of the water-free crop it appears that the chief differences between the two varieties are in the percentages of albuminoids and fiber. The water-free crop of the dent variety has in round numbers two and three-quarters per cent. more fiber, and one and three-quarters per cent. less albuminoids than the flint variety, and is, in so far, pound for pound less valuable as cattle food.

Regarding the composition of the sound kernels, the most striking difference between the two is in albuminoids. The dent variety has two and two-tenths per cent. less albuminoids than the flint. This might perhaps be explained by the fact that the flint was quite fully ripe when cut, but the dent was not, so that the kernels of the flint were fully filled, while in case of the dent the transportation of matter from stem and leaves to the kernel was checked by the cutting. But the higher percentage of albuminoids in the total crop of flint maize could hardly be accounted for in that way.

D. Differences in yield of Food-ingredients between the Dent and Flint Varieties.

Table XIX gives the total yield per acre of ash or mineral matter, albuminoids, fiber, etc. for each variety calculated from the yield of the plots where the rate of planting was nearest to that commonly employed.

TABLE XIX.—DENT AND FLINT VARIETIES COMPARED AS TO YIELD PER ACRE OF FOOD-INGREDIENTS.

	Ash.	Albuminoids.	Fiber.	Nitrogen-free extract.	Fat.
Dent maize ..	149.6	592.8	1484.2	5079.1	259.2
Flint maize ..	227.6	599.6	1066.5	4252.7	236.4

The dent variety yields very considerably more per acre of fiber and of nitrogen-free extract and somewhat more fat. The flint variety yields considerably more ash and about the same quantity of albuminoids as the dent.

There is another point of comparison between these two varieties which is brought out by experience in handling the crops. The flint variety molds much more readily than the dent and so cannot be handled or stored in the same way. Perhaps the explanation is that it packs much closer in the bundles or shooks than the dent, admits less circulation of air and for that reason will easier heat and spoil.

MAIZE RAISED FOR SEED.

As has been shown on pages 30–33 the individual maize plant reached its fullest development when the plants stood far apart.

The individual plant yielded a greater weight of water-free substance as well as of kernel and of all its other parts when it stood four feet from its neighbors than when it stood any closer. Some of the ears were remarkably large and if care had been taken to remove suckers which were very abundant and vigorous where the corn was thinnest planted, the yield of sound corn per plant would doubtless have been still larger.

If these plants were then the most productive in every way would it not pay to select from them seed corn for the next year and annually to plant some corn for seed much thinner than for the main crop, thus securing seed which should be specially prolific as is indeed occasionally recommended? The question is not so simple as it might seem at first glance.

Unquestionably the productiveness of a given variety of corn is kept up and increased within certain limits by selecting the most perfect ears in the crop each year for the next year's seeding. But it must be considered that the given variety is raised continually in the same way, being planted at approximately the same rate year after year and the ears are selected from plants which *planted in that way* are the most productive. Now if

maize is planted each year very thin for seed, it is almost certain that a sub-variety or strain will be established which will require to be planted further apart, in order to get a maximum crop than the original strain from which it originated and this maximum crop *may* not be any larger or even as large as that of the variety from which it came. Experiments in this direction would be extremely interesting.

Maize for Ensilage.

The special rates of planting followed in this experiment will not prove the best in all practice, of course, but the fact remains always and every where that the maximum yield possible under the given conditions of soil, cultivation and weather can be diminished by too thick planting as well as by thin planting, and this holds doubtless for maize cut green for ensilage as well as for maize which is allowed to ripen.

Very frequently in the endeavor to prevent the formation of ears, to fully utilize the ground and to make the crop tender and succulent by thick planting, the quantity of crop is considerably lessened. When maize is planted for ensilage or to be field-cured and fed without husking—as is Mr. Webb's practice—what is chiefly wanted is the maximum production of albuminoids, fat and carbhydrates.

The claim may be made that the aim is not *wholly* to get the largest yield of food-ingredients, but to get it free from hard stalks which are not as fully utilized by cattle as the leaves and immature ears and that while a larger crop may be got with thinner planting the thickest planting is actually the most profitable because the stalks are tender. In our opinion the claim is not a sound one. Feeders of ensilage agree that even large butts of stalks if properly cut are eaten clean, field-cured stalks if cut and shredded are also eaten clean, and when simply cut in an ensilage cutter Mr. Webb finds that there is very little waste.

There is no reason to believe that stalks which are eaten are any less digestible than other parts of the maize plant. Again there is a larger percentage of stalk in maize which stands closest as is shown in Table V though the stalks are quite small and tender. But again even if we reckon as valuable only half the substance of the stalks when planted two to a foot, and all the substance of the stalks as valuable when planted four or eight to a foot—a disparity which certainly does not exist,—the thinner

planting would still yield considerably more digestible albuminoids and fat than the thicker planting, and only a little less carbhydrates.

If a suitable variety of maize is planted at a rate to insure the maximum crop at harvest time, the quantity of ears or of stalks in it, will not damage it either for ensilage or for cutting up and feeding without husking in the field-cured condition.

It is however possible that a rate of planting which would give a maximum crop if cut when the maize was in the silk or just tasselling, would be too close to give the maximum crop if cut when the ears had fully formed. That is, it is possible, that when maize is to be cut *before it is fully developed* a thicker planting is advisable than when it is to be allowed to mature.

In the preceding pages we have reviewed the effects of the rate of planting on the quality and quantity of a single crop. The discussion may be closed with a very brief statement of the general facts regarding the subject which have been established by elaborate and painstaking work done elsewhere. These have been taken in substance from Dr. Ewald Wollny's treatise on the Planting and Cultivation of Farm Crops.

1. Other things being equal the largest possible *quantity* of crop can only be got by a certain rate of planting. Thinner or thicker seeding than this rate will lessen the crop. See Table III, page 17.

2. The *quality* of the crop is generally the best when the seeding is thin. The more ground given to single plants of a root crop, for instance, *within certain limits*, the larger and heavier will be the single roots or tubers, or in case of a grain crop the greater the distance of planting the plumper and heavier will be the grain ; i. e. a rate of planting which secures the best development of the individual plant is too thin or too low a rate to secure the largest crop. See page 30 and Table XI.

3. The proportion of straw or stover to grain increases as the stand is thicker. See Tables XV and XVI, pages 38 and 39.

4. While in general the yield of the single plant increases with the increase in the quantity of soil at its disposal up to a certain limit,—which of course is different for different species and varieties of plants,—this increase is not directly proportional to the increased area. See page 32.

These facts cannot be wholly explained by the limited capacity of the soil to furnish plant food. Plants do not by any means develop or yield proportionally to the quantity of plant food at their disposal or the area of soil at their command. There are a variety of other *factors of growth* which are also influenced by distance of planting. Among these are :

5. *Light.*—The plants of any crop always shade each other more or less, both from direct sun-light and from the diffused light of the sky. The thicker the stand the denser will be the shade, i. e. the smaller will be the quantity of light at the disposal of the individual plant. Without light, of course there can be no true growth ; when light is deficient growth is checked and the crop is smaller than it otherwise would be. There is no evidence that our crops ever suffer from *excess* of light, but they frequently suffer as a whole and almost always suffer in the individual development of the separate plants from lack of light, under the ordinary methods of planting.

6. *Heat.*—Fallow ground in summer, other conditions being alike, is warmer at and near the surface than ground covered by a crop, and the closer the stand of the crop the cooler will be both the surface soil and the air just above the surface.

The reason is that the ground surface is shielded by leaves from the direct rays of the sun, and their heat is largely expended in evaporating water rather than in heating the soil, and the less the heat penetrates the foliage the less the air will circulate and the greater will be the radiation of heat at night.

Now since the development and activity of the roots is affected very greatly by the soil temperature, it follows that the crop production is affected by the soil temperature, and so indirectly by the rate of planting.

7. *Water.*—While the evaporation per *single plant* of a crop thinly planted is greater than from one of a crop planted close, the *total evaporation* from thick planted crops is vastly greater than from those thin planted. Hence in time of drought the former is likely to suffer first and most. On the other hand, when rains are excessive the reverse may be the case ; the thick-planted crop may do best because the larger evaporation by the crop tends to keep the soil from being saturated with water and so from being deprived of air.

8. On the particulars already cited, light, heat and moisture depends largely the *tillering* of our cereals. Light is perhaps

the chief factor, but the others have also a decided effect. Where the seeding of grain is thinnest, other things being equal, is the greatest tendency to tiller and a rate of planting which would otherwise be too thin is corrected in a way by this tendency.

There are certain *special conditions* (to be distinguished from the general factors of growth already noted, such as light, heat and moisture) which modify the effects of rate of planting on the quantity and quality of the crop. Among these are

9. *Variety.*—As a general rule larger varieties which have a greater development of roots and leaves need more ground; i. e. a thinner rate of planting for their normal development than small varieties.

10. *Quality of Soil.*—First as regards the available plant food in it: the largest possible crop will be raised on a given soil which is heavily manured, with a thinner rate of seeding than would give the largest crop on the same soil, when unmanured. That is, a rich soil needs less seed to give a maximum crop than a poor soil.

The reason is evident. On rich land the growth and development of roots and leaves is much greater, and the demands made for light and heat are larger than on poor land. If now as much seed is sown on rich land as would be required to get the best possible crop on land containing less plant food, other things being equal, the plants on account of their more luxuriant growth will stand too thick and so the yield will be depressed.

Again, as regards the physical character of the soil: it follows from what has been said as to water that, other things being equal, soils retentive of moisture may be thicker planted than light, dry soils, always remembering that a soil which is really wet is a cold soil and thick planting also keeps the soil colder. The deeper the tilth, the more thorough the tillage and the cleaner of weeds is the soil, the thinner may be the planting.

Again, the more unfavorable the conditions of climate and weather are to the development of plants the thicker must be the sowing.

And lastly, the quality of the seed, whether old or fresh, heavy or light, large or small, has a great effect on the relative profitableness of different rates of planting. A proper discussion of this subject would carry us too far for the limits of this paper.

A brief summary of the results of this investigation is, from the nature of the case, impossible. We repeat here the special points which have been studied, giving references to the pages on which the conclusions reached are tabulated or summarized.

Effect of Distance of Planting on

A. Quantity of crop.

1. The gross yield. p. 16.
2. The quantity of dry (water-free) matter in the crop. p. 18.
3. The total weight of the separate parts of the dry crop. p. 18.
4. The proportional quantity of dry matter in each part of the crop. p. 20.

B. Quality of crop.

1. Percentage composition of the field-cured crops. p. 23.
2. Percentage composition of the separate parts of the field-cured crops. p. 24.
3. Percentage composition of the dry matter in the field-cured crops. p. 26.
4. Total quantity of food ingredients in the crops. p. 29.
5. Comparative development of the individual maize plant. p. 30.
6. Comparative composition of the individual maize plant. p. 33.
7. The quantities of nitrogen, phosphoric acid and potash removed in the crop. p. 34.

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Comparison of Flint and Dent Maize.

A. Difference in relative effects of distance of planting. p. 37.
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Maize raised for Seed. p. 43.

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General facts regarding distance of planting. p. 45.

THE CONNECTICUT FERTILIZER LAW.

The General Assembly at its session in 1882 passed a Fertilizer Law which went into effect September 1, 1882, and which repealed and took the place of all previous legislation on this subject. The law is still in force without any amendment.

Copies of the law may be had on application to the Station. Attention is specially called to the following points:

1. In case of fertilizers that retail at ten dollars or more per ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER shall have provided labels or statements and shall have paid the fee. Sections 1 and 3.

The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, viz: Nitrogen, Phosphoric acid and Potash. The analysis-fees in case of any fertilizer will therefore be ten, twenty or thirty dollars, according as one, two or three of these ingredients are contained or claimed to exist in the fertilizer

2. The law also requires, in case of any fertilizer selling at ten dollars or more per ton, that a *sealed sample* shall be deposited with the Director of the Station by the MANUFACTURER OR IMPORTER, and that a *certified statement* of composition, etc., shall be filed with him.

A statement of the per cents. of Nitrogen, Phosphoric acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the per cent. of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The per cent. of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of soluble and reverted.

Insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the chemical composition may take account of the two ingredients: Nitrogen, Phosphoric Acid.

For Potash Salts give always the per cent. of Potash (potassium oxide); that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price* shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4.

4. All "CHEMICALS" that are applied to land, such as: Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Lime (Gypsum or Land Plaster), Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 9 of the Act.

It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in section 9, that all fertilizers be analyzed and it requires the parties making or selling them to pay for these analyses in part; the State itself paying in part by maintaining the Experiment Station.

OBSERVANCE OF THE FERTILIZER LAW.

MANUFACTURERS who have paid Analysis Fees as required by the fertilizer Law, and FERTILIZERS for which the fees have been thus paid for the year ending May, 1890.

Firm.	*Brand of Fertilizer.*
Apothecaries Hall Co., Waterbury, Conn.	Victor Phosphate.
Baker, H. J. & Bro.. 215 Pearl St., N. Y.	A. A. Ammoniated Superphosphate. Potato Manure. Corn Manure. Ground Bone. Castor Pomace.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Stockbridge Grain Manure. " Forage Crop Manure. " Vegetable Manure. Bowker's Hill and Drill Phosphate. Fish and Potash. Ammoniated Dissolved Bone. Pure Dry Fish.
Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Bradley's Superphosphate. B. D. Sea Fowl Guano. Complete Manure for Potatoes and Vegetables. Complete Manure for Top Dressing Grass and Grain. Complete Manure for Corn and Grain. Potato Manure. Farmers New Method Fertilizer. Original Coe's Superphosphate. Pure Fine Ground Bone. Ground Bone and Potash, Circle Brand. Fish and Potash, "A" Brand. " " " Anchor Brand.
Coe, E. Frank, 16 Burling Slip, N. Y.	High Grade Ammoniated Superphosphate. Red Brand Excelsior Guano. Potato Fertilizer. Alkaline Bone. Ground Bone. Fish and Potash.
Cooper's, Peter, Glue Factory, 17 Burling Slip, N. Y.	Peter Cooper's Bone Dust.
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	New Rival Ammoniated Superphosphate. Buffalo Phosphate No. 2. Special Potato Manure. Pure Ground Bone. Ammoniated Bone Superphosphate. Potato, Hop and Tobacco Phosphate. Queen City Phosphate. Vegetable Bone Superphosphate. Ammoniated Wheat and Corn Phosphate.

Cumberland Bone Co., Portland, Me.	Cumberland Superphosphate. Seeding Down Fertilizer.
Darling, L. B. Fertilizer Co., Pawtucket, R. I.	Animal Fertilizer. Extra Bone Phosphate. Pure Ground Bone.
Davidge Fertilizer Co., 121 Front St., N. Y.	Potato Manure. Vegetator. Special Favorite.
Downs & Griffin, Derby, Conn.	Ground Bone.
Great Eastern Fertilizer Co., Rutland, Vt.	Gt. Eastern General Fertilizer for Grass and Grain. Gt. Eastern General Fertilizer for Vines and Tobacco. Gt. Eastern General Fertilizer for Oats, Buckwheat, and Seeding Down Phosphate.
Kelsey, E. R., Branford, Conn.	Fish and Potash.
Lister's Agricultural Chemical Works, Newark, N. J.	Ammoniated Dissolved Bone. Standard Superphosphate of Lime. Celebrated Ground Bone.
Ludlam, Frederick, 140 Maiden Lane, N. Y.	Cecrops Fertilizer. Cereal Fertilizer.
Mapes' Formula & Peruvian Guano Co., 158 Front St., N. Y.	Complete Manure for Light Soil. " " " general use. " " " "A" Brand. Potato Manure. Tobacco Manure, Conn. Brand. Fruit and Vine Manure. Corn Manure. Fine Dissolved Bone. Tobacco Manure, Wrapper Brand. Peruvian Guano. Grass and Grain Spring Top Dressing.
Meyer, C. Jr., Maspeth, L. I.	Acme Fertilizer. Acme Fertilizer, "E" Brand.
Miller, G. W., Middlefield, Conn.	Flour of Bone Phosphate. Pure Ground Bone.
Miller H. S. & Co., Newark, N. J.	Bone Meal. Harvest Queen Phosphate. Special Potato Manure.
Mitchell, A. Tremley, N. J.	Standard Phosphate.
National Fertilizer Co., Bridgeport, Ct.	Chittenden's Complete Fertilizer. " Ammoniated Bone Phosphate. Chittenden's Fish and Potash. " Ground Bone.
Nuhn, F. Waterbury, Conn.	Self-Recommending Fertilizer.
Orient Guano M'f'g Co., 16 and 18 Exchange Place, N. Y.	Orient Complete Manure. Fish and Potash.

Pacific Guano Co., Tremont Bank Building, Boston, Mass.	Soluble Pacific Guano. Fish and Potash.
Peck Bros., Northfield, Conn.	Pure Ground Bone.
Plumb & Winton, Bridgeport, Conn.	Ground Bone.
Prentice, Chas., Putnam, Conn.	Phosphate. Ground Bone.
Quinnipiac Co., New London, Conn.	Phosphate. Pine Island Phosphate. Potato Manure. Market Garden Manure. Fish and Potash—Crossed Fishes Brand. Fish and Potash—Pequot Brand. Dry Ground Fish Guano. Bone Meal.
Red Seal Castor Oil Co., St. Louis, Mo., by Olds & Whipple, Hartford.	Red Seal Castor Pomace.
Reed Fertilizer Co., New York, N. Y.	Farmers' Friend Brand. Lion Brand. High Grade Farmers' Friend. Samson or Lion Special.
Rogers & Hubbard Co., Middletown, Ct.	Complete Potato and Tobacco Manure. Fairchild's Formula for Corn and General Crops. Fairchild's Formula for Seeding Down. Raw Knuckle Bone Flour. Strictly Pure Fine Bone. Pure Ground AX Bone.
Sanderson, L., 87 Long Wharf, New Haven, Conn.	Formula "A." Sulphate of Ammonia. Kainit. Nitrate of Soda. Blood, Bone and Meat. Dissolved Bone Black. Muriate of Potash. Sulphate of Potash. Fine Ground Bone.
Shoemaker & Co., M. L., Philadelphia, Penn., by F. Ellsworth, Hartford.	Swift-Sure Bone Meal. Swift-Sure Superphosphate.
Standard Fertilizer Co., 118½ Milk St., Boston, Mass.	Standard Fertilizer. Standard Guano.
Taylor Bros., Rock Fall, Conn.	Ground Bone.
Thompson & Edwards Fertilizer Co., Union Stock Yards, Chicago, Ill.	Blood and Bone Animal Guano.
Wilkinson & Co., 52 and 54 Williams St., N. Y.	Economical Bone Fertilizer.
Williams & Clark Co., 81 Fulton St., N. Y.	Americus Ammoniated Bone Superphosphate. Potato Phosphate. Bone Meal. Royal Bone Phosphate. Universal Phosphate. Tobacco Phosphate.

ANALYSES OF FERTILIZERS.*

During 1889, 242 samples of fertilizers have been analyzed. Of these, a small number were examined for private parties and for testing methods in connection with other Experiment Stations, and the remainder for the general use of the citizens of the State.

During April and May last Messrs. H. W. Yeomans, of Columbia, and Dennis Fenn of Milford, agents of this Station, collected samples of Commercial Fertilizers in all parts of Connecticut. 127 towns and villages have been visited, distributed as follows:

Hartford Co.	24
Tolland Co.	11
Windham Co.	17
New London Co.	8
Middlesex Co.	14
New Haven Co.	19
Fairfield Co.	18
Litchfield Co.	16
	127

These gentlemen drew about 580 samples by using the method of sampling which is described on page 91 of the Report of this Station for 1884.

In this way one or more samples were secured of nearly every brand of fertilizer which is offered for sale within the State. When several samples of a single brand were drawn in different parts of the State the analysis was performed, not on any single sample, but on a mixture made of an equal weight of each of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of any single sample.

The Station agents are instructed in every case to open at least three packages of each brand for sampling and if the number of packages is large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core through the entire length of the bag or barrel.

* The matter of this and several subsequent pages, explanatory of the sampling and valuation of fertilizers, is copied, with a few appropriate alterations, from the Report for 1887. This repetition appears to be necessary for the use of readers who have not seen former Reports.

As a rule the Station will not analyze samples—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

The Station desires the co-operation of farmers, farmers' clubs and granges in calling attention to new brands of fertilizers and in securing samples of all goods offered for sale. All samples drawn by other than Station agents *must* be drawn in accordance with the Station's Instructions for sampling and properly certified, if the station analysis is desired. A copy of these instructions and blank certificates will be sent on application.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a copy of it is sent to the party who furnished the sample and also to the manufacturer, in order that there may be opportunity for explanation or protest, if desirable, before the results are published in the Bulletin.

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

Explanations Concerning the Analysis of Fertilizers and the Valuation of their Active Ingredients.

Revised.

Nitrogen is the most rare, and commercially, the most valuable fertilizing element.

Free Nitrogen is indeed universally abundant in the common air, but in this form its effects in nourishing vegetation are as yet obscure.

Organic Nitrogen is the nitrogen of animal and vegetable matters, which is chemically united to carbon, hydrogen and oxygen. Some forms of organic nitrogen, as those of blood, flesh and seeds, are highly active as fertilizers; others, as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated.

Ammonia (NH_3) *and nitric acid* (N_2O_5) are results of the decay of *organic nitrogen* in the soil and manure heap, and contain Nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda. 17 parts of ammonia or 66 parts of pure sulphate of ammonia contain 14 parts of nitrogen. 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

Phosphorus is, next to nitrogen, the most costly ingredient of Fertilizers, in which it always exists in the form of phosphates, usually those of calcium, iron, and aluminum, or in case of some "superphosphates" in the form of free phosphoric acid.

Soluble Phosphoric acid implies phosphoric acid or phosphates that are freely soluble in water. It is the characteristic ingredient of Superphosphates, in which it is produced, by acting on "insoluble" or "reverted" phosphates, with diluted sulphuric acid (oil of vitriol). Once well incorporated with the soil it gradually becomes reverted phosphoric acid.

Reverted (reduced or precipitated) Phosphoric acid means strictly, phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid. In present usage the term signifies the phosphoric acid (of various phosphates) that is freely taken up by a strong solution of ammonium citrate, which is therefore used in analysis to determine its quantity. "Reverted phosphoric acid" implies phosphates that are readily assimilated by crops.

Recent investigation tends to show that soluble and reverted phosphoric acid are on the whole about equally valuable as plant-food and of nearly equal commercial value. In some cases, indeed, the soluble gives better results on crops, in others the reverted is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric acid implies various phosphates not soluble in water or ammonium citrate. In some cases the phosphoric acid is too

insoluble to be readily available as plant-food. This is especially true of the crystallized green Canada Apatite. Bone-black, bone-ash, South Carolina Rock and Navassa Phosphate when in coarse powder are commonly of little repute as fertilizers though good results are occasionally reported from their use. When *very finely pulverized* ("floats") they more often act well, especially in connection with abundance of decaying vegetable matters. The phosphate of calcium in raw bones is nearly insoluble, because of the animal matter of the bones, which envelopes it; but when the latter decays in the soil, the phosphate remains in essentially the "reverted" form. The phosphoric acid of "Thomas-Slag" and of "Grand Cayman's Phosphate" is freely taken up by crops.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid" (P_2O_5) also termed among chemists, phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

POTASSIUM is the constituent of Fertilizers, which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the shape of muriate (potassium chloride).

The Valuation of a Fertilizer, as practised at this Station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw materials of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and similar articles, for which $30 to $50 per ton are paid, depend chiefly for their trade-value on the three substances, *nitrogen*, *phosphoric acid* and *potash*, which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above-named Ingredients*, a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

The average Trade-values or retail cost in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash, as found in the New England, New York and New Jersey markets, are as follows:—

The Trade-Values for 1889 of Fertilizing Ingredients in Raw Materials and Chemicals.

The average Trade-Values or *retail cost per pound* of the ordinarily occurring forms of nitrogen, phosphoric and potash are as follows:

	Cts. per lb.
Nitrogen in ammonia salts	19
nitrates	17
Organic nitrogen in dry and fine ground fish, meat and blood	19
in cotton seed meal and castor pomace	15
in fine bone and tankage	16½
in fine medium bone and tankage	13
in medium bone and tankage	10½
in coarser bone and tankage	8½
in hair, horn shavings and coarse fish scrap	8
Phosphoric acid, soluble in water	8
in ammonium citrate*	7½
in dry ground fish, fine bone and tankage	7
in fine-medium bone and tankage	6
in medium bone and tankage	5
in coarser bone and tankage	4
in fine ground rock phosphate	2
Potash as high-grade Sulphate and in forms free from Muriate (or Chlorides)	6
as kainit	4½
as muriate	4½

These Trade-values were agreed upon by the Experiment stations of Massachusetts, New Jersey, Pennsylvania and Connecticut, for use in their respective States during 1889. They are the average prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those raw materials which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices* at the large markets of standard raw materials, such as:

Sulphate of Ammonia,	Muriate of Potash,
Nitrate of Soda,	Sulphate of potash,
Dried blood,	Plain Superphosphate,
Azotin,	Dry Ground Fish,
Ammonite,	Bone and Tankage,

Ground So. Carolina Rock.

*Dissolved from 2 grams of the unground phosphate previously extracted with pure water, by 100 c. c. neutral solution of Ammonium Citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

Valuation of Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The organic nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality.

Insoluble Phosphoric Acid is reckoned at 3 cents, unless found to be from rock phosphate. In this latter form Insoluble Phosphoric Acid costs but 2 cents per pound. Potash is rated at 4½ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of Potash is reckoned at 6 cents.

In most cases the valuation of the Ingredients in Superphosphates and Specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. These charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investments, bad debts, and finally, profits.

The majority of the manufacturers agree that the average cost of mixing, bagging, handling and cartage ranges from $3.00 to $4.50 per ton.

In 1889 the average selling price of Ammoniated Superphosphates, and Guanos was $34.10, the average valuation was $29.10, and the difference $5.00—an advance of 17.2 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

In case of Special Manures the average cost was $40.25, the average valuation $35.20, and the difference $5.05, or 14.3 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of Nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

In case of *Ground Bone*, the sample is sifted into four grades and we separately compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton, by the per cent. of each grade, taking $\frac{1}{100}$th of that product, multiplying it by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade, thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

The uses of the "Valuation" are twofold:

1, To show whether a given lot or brand of fertilizers is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price; but

in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

2, Comparisons of the valuations and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for analysis cannot always decide accurately what is the *form* of nitrogen, etc., while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second-named use of valuation frequent changes of the trade-values are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth, when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of a year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

The Agricultural value of a fertilizer is measured by the benefit received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that Peruvian guano, superphosphates, fish-scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

CLASSIFICATION OF FERTILIZERS ANALYZED.

The fertilizers and manurial waste products analyzed at the Station laboratory from November 1st, 1888, to November 1st, 1889, were as follows :

RAW MATERIALS COMMONLY USED IN MIXED FERTILIZERS.

1. *Containing Nitrogen as the Chief Valuable Ingredient.*

Nitrate of Soda	3
Sulphate of Ammonia	2
Dried Blood	1
Cotton Seed Meal	6
Castor Pomace	3
Horn Shavings	1

2. *Containing Phosphoric Acid as the Chief Valuable Ingredient.*

Bone Black	1
Phosphatic Guano	2
Dissolved Bone Black	5

3. *Containing Potash as the Chief Valuable Ingredient.*

High Grade Sulphate of Potash	1
Double Sulphate of Potash and Magnesia	4
Muriate of Potash	4
Kainit	2
Sylvinit	1

4. *Containing Nitrogen and Phosphoric Acid.*

Bone Manures	31
Tankage	8
Dry Ground Fish	2

MIXED FERTILIZERS.

Nitrogenous Superphosphates and Guanos	82
Special Manures	36
Home-mixed Fertilizers	12

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes	12
Unleached Wood Ashes	9
Ashes from flues of boiler	1
Tobacco Stems	2
Wool Waste	1
Damaged Corn	1
Muck	1
Salt Marsh Mud	3
Mussels	1
Plaster	1
Yard Manure	2
Hall's Coral Fertilizer	1
Total	242

These analyses are discussed in the order above given on the following pages.—In all cases where the contrary is not stated, the samples were drawn by agents of the Station. The regular retail prices are in all cases given. By special terms with the dealer in many cases the actual cash prices paid have been much less.

I. Raw Materials of High-Grade Containing Nitrogen as the Chief Valuable Ingredient.

Nitrate of Soda.

Nitrate of Soda is mined in Chili and purified there before shipment. It usually contains about 16 per cent. of nitrogen, equivalent to 97 per cent. of pure nitrate of soda. It contains besides, a little salt and some moisture. The usual guarantee is "96 per cent." of nitrate of soda equivalent to 15.8 per cent. of nitrogen.

2438. Stock of Rogers & Hubbard Co., Middletown. Guaranteed 98 per cent.

2468. Sold by L. Sanderson, New Haven. From stock bought by W. H. Hammond, Elliott. Guaranteed 95 per cent.

2427. Stock of L. Sanderson, New Haven. Guaranteed 95 per cent.

Analyses.

	2438	2468	2427
Moisture	1.59	2.61	1.31
Salt [sodium chloride]	.60	.79	.36
Sulphate of soda	.27	.73	3.02
Pure Nitrate of soda	97.54	95.87	95.20
Matters insoluble in water	----	----	.11
	100.00	100.00	100.00
Contains nitrogen	16.07	15.80	15.70
Cost per ton	$56.00	55.00*	55.00
Nitrogen costs per pound in cents	17.4	17.4	17.5

* Dealer's regular price at store.

Sulphate of Ammonia.

This article, now made on a large scale as a by-product of gas-works, usually contains over 20 per cent. of nitrogen, the equivalent of from 94 to 97 per cent. of sulphate of ammonia. The rest is chiefly moisture. The usual guarantee is 25 per cent.

of ammonia which is equivalent to 20.6 per cent. of nitrogen, but commercial sulphate of ammonia commonly contains less than that quantity.

2405. From stock of L. Sanderson, New Haven. Guaranteed 25 per cent. of ammonia.

2443. From stock bought by Dennis Fenn of C. Meyer, Jr., Maspeth, L. I. Guaranteed 24.5 per cent. of ammonia.

ANALYSES.

	2405	2443
Nitrogen	20.46	20.88
Equivalent ammonia	24.85	25.35
Cost per ton	$75.00	74.60
Nitrogen costs per pound in cents	18.3	17.9

DRIED BLOOD.

This material consists chiefly of the blood of cattle killed at slaughter houses, which is dried by steam or in kilns till it contains from 10–12 per cent. of water, and in that condition will keep indefinitely.

2631. Stock of L. Sanderson, New Haven. This contained 12.20 per cent. of nitrogen and cost $50 per ton, making **the cost of nitrogen 20.5 cents per pound.**

COTTON SEED MEAL.

The seed of the cotton plant, after ginning to remove the cotton fibre, passes through a mill which hulls or decorticates it. The hulled seed is ground and the oil is expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer.

2421. Sold by J. E. Soper & Co., Boston. Sampled and sent by Edmund Halladay, Suffield.

2596. Sold by Olds & Whipple, Hartford. Sampled and sent by Station Agent.

2450. Sold by J. E. Soper & Co., Boston. Sampled and sent by H. S. Frye, Poquonock. Guaranteed 7.74 per cent. nitrogen.

2449. Sold by J. E. Soper & Co., Boston. Sampled and sent by H. S. Frye, Poquonock. Guaranteed 7.74 per cent. nitrogen.

2492. Sold by C. L. Spencer, Suffield, to Edward Austin. Sampled and sent by Allen Wilson, Suffield.

2494. Sold by Allen Wilson, Suffield, to Edward Austin. Sampled and sent by Allen Wilson.

ANALYSES.

	2421	2596	2450	2449	2492	2494
Nitrogen	6.94	7.50	7.17	6.75	6.87	6.65
Phosphoric acid	2.71	3.49	2.70	2.56	3.22	3.48
Potash	1.85	2.06	1.84	1.83	2.03	1.94
Cost per ton	$23.00*	26.00	24.00*	24.00*	27.00	27.00
Nitrogen costs per pound in cents	12.2	12.4	12.5	13.5	14.6	14.9

* In car lots.

Nos. **2449** and **2450** were received from H. S. Frye, Poquonock, who states that they are fair samples from a car lot bought of J. E. Soper & Co., Boston, on sample shown, and analysis giving 7.74 per cent. nitrogen; that the meal came in bags of all sizes from 75 to 160 pounds, and that it was of all grades and colors, light and dark, coarse and fine; that after correspondence the seller charged one dollar less per ton than was at first asked. Mr. Frye estimates that 20 per cent. of the meal is coarse. The mechanical condition of the two grades is as follows:

	2449	2450
Fine, smaller than $\frac{1}{50}$ inch	3	52
Fine medium, smaller than $\frac{1}{28}$ inch	1	22
Medium, smaller than $\frac{1}{14}$ inch	4	22
Coarse, larger than $\frac{1}{14}$ inch	92	4
	100	100

The coarse meal which apparently contained more hulls, contained also .40 per cent. less nitrogen and by reason also of its coarseness was much less valuable as a fertilizer.

Valuing phosphoric acid and potash at 7 and 6 cents per pound respectively—the rates used in the valuation of mixed fertilizers—nitrogen in cotton seed meal has cost at retail from 12½ to 15 cents per pound. It still remains, as last year, the cheapest source of quickly available nitrogen.

CASTOR POMACE.

This is the ground residue or cake of castor beans from which castor oil has been extracted by pressure.

2439. Stock of F. Ellsworth, Hartford. Guaranteed 5.75 per cent. nitrogen, 1.80 phosphoric acid, 1.30 potash.

2595. Made by the Red Seal Castor Oil Co., St. Louis. Sold by Olds & Whipple, Hartford.

2584. Made by H. J. Baker & Bro., 215 Pearl St., New York. Sampled from stock of W. F. Andross, E. Hartford, and W. W. Clark, Simsbury.

ANALYSES.

	2439	2595	2584
Nitrogen	5.52	5.54	5.60
Phosphoric acid	2.37	2.12	1.88
Potash	1.16	1.04	1.04
Cost per ton	$25.00	25.00	25.00
Nitrogen costs per pound	18.3 cts.	18.7 cts.	18.9 cts.

The price of Castor Pomace has advanced $5.00 per ton since the spring of 1888 and in consequence it has become one of the most costly sources of nitrogen, whereas in 1888 it was one of the cheapest.

HORN SHAVINGS.

2634. Sent by Lawrence Doyle of Harwinton. These shavings which are quite fine are stated to be from a factory in which the horn is boiled in a mixture of raw linseed oil and tallow previous to working it. Applied in very large amount the shavings are said to have been rather a damage than a benefit to land. The sample contained considerable insoluble foreign matter and 8.43 per cent. of nitrogen.

II. RAW MATERIALS OF HIGH GRADE CONTAINING PHOSPHORIC ACID.

BONE BLACK OR BONE CHAR.

2475. Sampled and sent by E. R. Kelsey, Branford. Taken from a factory where small articles of iron are case-hardened. It contains 7.98 per cent. of sand and soil and 34.98 per cent. of phosphoric acid. This material is little if any quicker in its action than raw South Carolina rock, but is an excellent material for making superphosphate, and when it is produced as a waste product in small quantities only, may sometimes be had for the carting or at a low price. Directions for treating it with acid are given in the Report of this Station for 1883, page 29. Mr. Kelsey's method of treating it and the results are given on the next page.

Dissolved Bone Black.

This material is a superphosphate prepared by treating refuse bone black from sugar refineries with oil of vitriol which renders nearly all of the phosphoric acid soluble in water.

2447. Sold by C. Meyer, Jr., Maspeth, L. I. From stock of Dennis Fenn, Milford. Guaranteed 16 per cent. phosphoric acid.

2428. Sold by L. Sanderson, New Haven. Guaranteed 16 per cent. soluble and reverted.

2471. Sold by L. Sanderson, New Haven. From stock bought by W. H. Hammond, Elliott.

2451. Sold by L. Sanderson, New Haven.

2633. Dissolved Bone Black made by E. R. Kelsey from Bone Char No. **2475** by the following formula: 175 pounds oil of vitriol 50° B., 60 pounds of water and 235 pounds of bone black. Its cost is not known. The valuation would be $26.45 per ton.

Analyses.

	2447	2428	2471	2451	2633
Soluble phosphoric acid	13.33	16.95	15.32	15.59	12.75
Reverted phosphoric acid	3.93	.06	.68	.08	3.50
Insoluble phosphoric acid	1.74	none	.12	.09	1.99
Cost per ton	$26.00	26.00	26.00*	26.00	....
Soluble phosphoric acid costs per pound in cents	7.2	7.6	8.1	8.3	....

* Regular retail price at dealer's store.

Valuing reverted and insoluble phosphoric acid at 7½ and 2 cents per pound respectively, soluble phosphoric acid has cost from 7 to 8½ cents per pound. Attention is again called to the fact that soluble phosphoric acid can be bought a good deal cheaper in dissolved South Carolina rock. Granges, and farmers' clubs that buy in considerable quantity would do well to inquire for it.

III. Raw Materials of High Grade Containing Potash.

High Grade Sulphate of Potash.

This material contains over 96 per cent. of pure sulphate of potash or about the same quantity of actual potash as the muriate, but contains no more than a trace of chlorine.

2444. Sold by C. Meyer, Jr., Maspeth, L. I. From stock bought by G. F. Platt, Milford. Guaranteed 52 per cent. potash. The analysis is given in the next table.

Double Sulphate of Potash and Magnesia.

This material is usually sold as "sulphate of potash" or "manure salt," on a guarantee of "48–50 per cent. sulphate," which is equivalent to 25.9–27 per cent. of actual potash. It contains, besides some 46–50 per cent. of sulphate of potash, over 30 per cent. of sulphate of magnesia, chlorine equivalent to 3 per cent. of common salt, besides sulphates of soda and lime, with varying quantities of moisture.

2423. Double sulphate of potash. Stock of L. Sanderson, New Haven. Guaranteed 50 per cent. sulphate.

2469. Sulphate of potash. Sold by L. Sanderson, New Haven, to W. H. Hammond, Elliott. Guaranteed 50 per cent. sulphate.

2445. Sulphate of potash. Sold by C. Meyer, Jr., Maspeth, L. I. From stock bought by G. F. Platt, Milford. Guaranteed 27 per cent. actual potash.

2495. Sulphate of potash. From stock bought of Merritt, Beach & Co., New Milford. Sampled and sent by Mr. Bostwick, New Milford.

Analyses.

	2444	2423	2469	2445	2495
Actual potash	52.23	27.82	25.40	25.98	23.61
Equivalent sulphate of potash	96.6	51.3	46.9	48.1	43.5
Cost per ton	$61.20	30.00	30.00*	30.60	40.00
Potash costs per pound in cents	5.8	5.4	5.9	5.9	----

* Regular price at dealer's store.

The high grade sulphate of potash (No. 2444) at $61.20 per ton is about as cheap a source of potash as the double Sulphate at $30.00.

Muriate of Potash.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride), 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water. It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of actual potash.

2446. From stock bought of C. Meyer, Jr., Maspeth, L. I., by G. F. Platt, Milford. Guaranteed 82 per cent. muriate.

2442. Stock of L. Sanderson, New Haven. Guaranteed 80 per cent. muriate.

2434. Stock of the Rogers & Hubbard Co., Middletown. Guaranteed 80 per cent. muriate.

2470. From stock bought of L. Sanderson, New Haven, by W. H. Hammond, Elliott. Guaranteed 80 per cent. muriate.

ANALYSES.

	2446	2442	2434	2470
Actual potash	51.75	52.11	52.39	46.58
Equivalent muriate	81.9	82.3	82.8	73.6
Cost per ton	$41.60	42.50	44.00	*42.50
Cost of potash per pound in cents	4	4.1	4.2	4.6

* Regular price at dealer's store.

KAINIT.

Kainit is less uniform in composition than the other potash salts. It contains from 11 to 15 per cent. of potash, more than that quantity of soda, and rather less magnesia. These "bases" are combined with chlorine and sulphuric acid. Unless "calcined" it contains more water than the sulphate or muriate of potash. It is usually sold on a guarantee of 12 to 15 per cent. of potash, or 23 to 25 per cent. "sulphate of potash." It cannot properly be called or be used as a sulphate of potash, because it contains more than enough chlorine to combine with all the potash present and there is every reason to believe that its potash exists as muriate and not as sulphate.

2467. Sold by L. Sanderson, New Haven, to W. H. Hammond, Elliott. Guaranteed 12 per cent. of potash.

2425. Sold by L. Sanderson, New Haven.

ANALYSES.

	2467	2425
Actual potash	13.20	12.58
Cost per ton	$12.50	12.50
Potash costs per pound in cents	4.7	4.9

SYLVINIT.

This is a product of the Stassfurt potash industry which is used by manufacturers of mixed fertilizers and may be offered in the retail trade. Like kainit it is offered as a "Sulphate of Potash," but like kainit also, it cannot be properly regarded as such, for it does not contain enough sulphuric acid to combine with all the potash present, and moreover, contains between three and four times as much chlorine as sulphuric acid. A sample,

No. **2629,** drawn from a single bag in New York City, had the following composition :

Water	7.25
Potash	16.65
Soda	27.10
Lime	2.08
Magnesia	3.37
Sulphuric acid	11.06
Chlorine	41.35
Matters insoluble in water	.74
	109.60
Deduct oxygen equivalent to chlorine	9.34
	100.26

Sylvinit contains rather more potash than kainit and consists of sulphates and muriates of potash and soda, the muriates preponderating.

IV. Raw Materials Containing Nitrogen and Phosphoric Acid.

Bone Manures.

The terms "Bone Dust," "Ground Bone," "Bone Meal" and "Bone" applied to fertilizers, may in some cases signify material, made from dry, clean and pure bones such as shank bones used in making knife handles ; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon, and grease—and if taken from garbage or ash heaps, with ashes or soil adhering ; again they denote mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam-tanks in order to recover grease, and are then dried and sold as "tankage ;" or, finally, they apply to bone from which a large share of the nitrogenous substance has been extracted in the glue manufacture. The nitrogen of all these varieties of bone when they are in the same state of mechanical subdivision has essentially the same fertilizing value.

Since the establishment of this Station, twelve years ago, there has been a great improvement in the mechanical condition of the bone manures sold in Connecticut, as is seen from the following

table, which gives the average fineness of all those which have been analyzed during that period :*

MECHANICAL ANALYSIS.

Year.	Number of samples.	Smaller than $\frac{1}{15}$ inch.	Between $\frac{1}{8}$ and $\frac{1}{15}$ inch.	Larger than $\frac{1}{8}$ inch.
1877	7	57	18	25
1878	57	52	35	13
1879	11	59	35	6
1880	13	66	27	7
1881	18	55	33	12
1882	20	61	34	5
1883†	12	54	39	7
1884	13	60	31	9
1885	13	67	32	1
1886	16	66	32	2
1887	20	83	15	2
1888	26	74	23	3
1889	19	71	29	0

Within the last four years few samples have contained fragments which would not pass holes $\frac{1}{8}$ of an inch in diameter and a larger proportion than formerly has been of the two finest grades.

The improved condition and increased value of our bone-manures is to some extent a result of the action of this Station which in the year 1879 first carried into effect the method of valuation based on the mechanical as well as the chemical analysis. Nitrogen in the finest bone is now worth 16½ cents per pound, while that in the coarsest bone is valued at only 8½ cents, and phosphoric acid is valued at 7 and 4 cents in the two grades respectively. Very finely ground bone is, at present, one of the cheapest sources of quickly available nitrogen and phosphoric acid.

The method used for the valuation of bone is explained on page 59.

1. *Sampled by Station Agents.*

On pages 71 to 73 will be found the tabulated analyses of 20 samples of bone manures sampled by the Station.

Leaving out 2574 which is a mixture of potash salts and bone the average cost of 19 samples has been $34.11, the average valu-

* This table differs slightly from a similar one given in Bulletin No. 99, of which it is a revision.

† From 1883 on only those analyses are averaged which were made on samples drawn by station agents.

Bone Manures.—Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost Per Ton.
2605	Ground Bone.	H. S. Miller & Co., Newark, N. J.	Staples & Raymond, Westport.	$28.00
				37.00
2435	Raw Knuckle Bone Flour.	Rogers & Hubbard Co., Middletown, Conn.	Manufacturer.	
2436	Strictly Pure Fine Bone.	Rogers & Hubbard Co., Middletown, Conn.	Manufacturer.	34.00
2441	Pure Ground Bone.	C. Meyer, Jr., Maspeth, L. I.	Bought of the manufacturer by G. F. Platt, Milford.	35.00
2597	Pure Bone.	Quinnipiac Co., New London, Conn.	E. N. Pierce & Co., Plainville.	37.00
			Jas. P. Little, Columbia.	34.00
			Chandler & Morse, Putnam.	34.00
			Manufacturer.	34.00
			E. A. Godfrey, Southport.	31.00
			R. W. Burchard, Darien.	35.00
2576	Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	J. P. Barstow & Co, Norwich.	35.00
			Comstock, Ferre & Co., Wethersfield.	----
2431	Pure Ground AX Bone.	Rogers & Hubbard Co., Middletown, Conn.	Manufacturer.	32.00
2466	Fine Ground Bone.	L. Sanderson, 87 Long Wharf, New Haven, Conn.	W. H. Hammond, Elliott.	----
2580	Swift Sure Bone Meal.	M. L. Shoemaker & Co., Philadelphia, Penn.	Atwood & Wilson, Watertown.	35.00
			J. P. Barstow & Co., Norwich.	38.00
			F. Ellsworth, Hartford.	40.00

Bone Manures.—Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost Per Ton.
2577	Pure Ground Bone.	Downs & Griffin, Derby, Conn.	Atwood & Wilson, Watertown.	$20.00
2424	Fine Ground Bone.	L. Sanderson, 87 Long Wharf, New Haven, Conn.	Manufacturer.	35.00
2579	Fine Bone.	Chas. Prentice, Putnam, Conn.	R. S. Williams, Hampton.	34.00
2581	Pure Ground Bone.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	E. C. Dennis, Stafford Springs.	33.00
			G. A. Dickinson, Haddam.	36.00
			R. A. Parker, Warehouse Point.	38.00
			Waterbury & June, Greenwich.	35.00
2440	Pure Ground Bone.	C. Meyer, Jr., Maspeth, L. I.	Bought of manufacturer by G. F. Platt, Milford.	35.00
2575	Ground Bone.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	J. L. Bragg, Canaan.	37.00
			Chandler & Morse, Putnam.	34.00
2601	Chittenden's Ground Bone.	National Fertilizer Co., Bridgeport, Conn.	F. P. Burr & Co., Middletown.	35.00
			L. W. Currier, Bridgeport.	35.00
2578	Pure Ground Bone.	Peck Bros., Northfield, Conn.	J. H. French, Cheshire.	----
2614	Pure Bone Meal.	Williams & Clark Co., 81 Fulton St., New York.	B. E. Johnson, Higganum.	35.00
			W. F. Payne, Rockville.	35.00
			Daniel Morgan, Poquonock.	35.00
2574	Ground Bone with Potash.	E. Frank Coe, 16 Burling Slip, New York.	Simon Banks, Southport.	28.00
			Hillhouse & Taylor, Willimantic.	35.00

Bone Manures.—Sampled by the Station.

Station No.	Name or Brand.	Chemical Analysis.		Mechanical Analysis.					Cost per ton.	Valuation per ton.	Percentage difference between cost and valuation.
				Finer than				Coarser than			
		Nitrogen.	Phos. Acid.	1/60 inch.	1/35 inch.	1/15 inch.	1/8 inch.	1/8 inch.			
											Valuation exceeds cost.
2605	H. S. Miller's Ground Bone	1.85	25.52	58	25	17	--	--	$28.00	$38.12	26.5
2435	Rogers & Hubbard Co's Raw Knuckle Bone Flour	3.60	25.70	74	24	2	--	--	37.00	45.73	19.0
2436	Rogers & Hubbard Co's Strictly Pure Fine Bone	3.80	22.80	51	32	17	--	--	34.00	39.82	14.6
2441	Meyer's Pure Ground Bone	3.37	22.36	62	37	1	--	--	35.00	39.77	11.9
2597	Quinnipiac Pure Bone	3.00	23.77	54	26	17	3	--	34.00	38.59	11.8
2576	Darling's Ground Bone	2.40	24.69	65	24	11	--	--	35.00	39.48	11.3
2431	Rogers & Hubbard Co's Pure Ground AX Bone	3.72	21.90	43	20	25	12	--	32.00	35.95	10.9
2466	Sanderson's Fine Ground Bone	1.87	27.57	50	25	17	8	--	35.00	39.24	10.7
2580	Shoemaker's Swift Sure Bone Meal	5.15	23.32	53	30	17	--	--	40.00	44.51	10.1
2577	Downs & Griffin's Pure Ground Bone	4.09	22.60	18	17	31	34	--	30.00	32.72	8.3
2424	Sanderson's Fine Ground Bone	1.69	27.55	46	21	26	7	--	35.00	38.00	7.9
2579	Chas. Prentice's Fine Bone	4.24	22.72	34	23	19	24	--	34.00	36.47	6.7
2581	Bradley's Pure Ground Bone	4.06	21.07	35	45	20	--	--	35.00	37.06	5.5
2440	Meyer's Pure Ground Bone	2.94	23.07	45	28	26	1	--	35.00	36.63	4.4
2575	Crocker's Ground Bone	4.37	23.98	23	25	25	27	--	35.00	36.54	4.2
2601	Chittenden's Ground Bone	2.58	23.63	44	26	15	15	--	35.00	35.27	.7
											Cost exceeds valuation.
2578	Peck Bros' Pure Ground Bone	4.03	20.09	6	28	26	40	--	30.00	28.76	4.3
2614	Williams & Clark's Pure Bone Meal	4.07	18.57	37	25	23	15	--	35.00	32.31	8.3
2574	Ground Bone with Potash	1.62	*17.88	35	30	22	13	--	31.50	26.57	18.5

* Also contains 1.49 per cent. of Potash.

ation $37.49. The agreement between average cost and valuation is near enough to be satisfactory and shows that the Station's trade values are substantially correct as regards bone.

2. *Manufacturers' Samples and Samples sent by Purchasers.*

2406. Plumb & Winton's Pure Ground Bone. Made by Plumb & Winton, Bridgeport. From stock sold to T. E. Platt, Newtown. Sampled and sent by T. E. Platt.

2412. Self-Recommending Fertilizer. Made and sampled by F. Nuhn, Waterbury.

2452. Ground Bone. Made and sampled by Plumb & Winton, Bridgeport.

2585. Lister's Celebrated Ground Bone. Sold by Lister's Fertilizer Chemical Works, Newark, N. J.

2586. Darling's Bone. Sold by L. B. Darling Fertilizer Co., Pawtucket, R. I. Sampled and sent by R. A. Moore, Kensington.

2619. Ground Bone. Made and sampled by Taylor Bros., Rockfall.

2635. Pure Ground Bone. Made by Downs & Griffin, Derby. Sampled and sent by E. H. Wakeley, Ansonia.

MECHANICAL ANALYSES.

	2406	2412	2452	2585	2586	2619	2635
Fine, smaller than $\frac{1}{10}$ inch	49	64	59	35	53	25	21
Fine medium, smaller than $\frac{1}{5}$ inch	16	15	18	25	23	26	24
Medium, smaller than $\frac{1}{2}$ inch	15	14	13	20	22	27	36
Coarse, larger than $\frac{1}{8}$ inch	20	7	10	20	2	22	19

CHEMICAL ANALYSES.

	2406	2412	2452	2585	2586	2619	2635
Nitrogen	3.01	3.73	4.80	2.92	3.00	3.21	4.00
Phosphoric Acid	20.10	20.98	18.55	11.55	23.61	21.23	23.72
Potash	....	2.96	....	....	....	....	....
Cost per ton	$30.00		30.00		35.00		30.00
Valuation per ton	$31.97	40.07	36.94	20.77	38.14	31.42	35.52

TANKAGE.

2430. Sold by L. Sanderson, New Haven. Sampled by J. H. Hale, South Glastonbury.

2426. Blood, Bone and Meat. Sold by L. Sanderson, New Haven.

2472. Blood, Bone and Meat. Sold by L. Sanderson. From stock purchased by W. H. Hammond, Elliott.

2442. Sold by C. Meyer, Jr., Maspeth, L. I. From stock sold to G. F. Platt, and Dennis Fenn, Milford.

MECHANICAL ANALYSES.

	2430	2426	2472	2442
Fine, smaller than $\frac{1}{20}$ inch	92	78	46	14
Fine medium, smaller than $\frac{1}{10}$ inch	8	12	26	26
Medium, smaller than $\frac{1}{5}$ inch	--	7	18	26
Coarse, larger than $\frac{1}{5}$ inch	--	3	10	34

CHEMICAL ANALYSES.

	2430	2426	2472	2442
Nitrogen	4.55	4.18	6.60	8.41
Phosphoric acid	21.44	21.78	12.26	2.29
Cost per ton	$35.00	35.00	35.00	28.60
Valuation per ton	$44.43	41.86	33.01	21.50

The low valuation of **2442** is due to its coarse mechanical condition. The coarsest lumps were however readily pulverizable.

2598. Blood and Bone Animal Guano. Made by Thompson & Edwards Fertilizer Co., Chicago, Ill. Sampled from stock of Arnold Warren, Willimantic. Guarantee 2.4 per cent. Nitrogen, 13.7 phosphoric acid and 7 per cent. sulphate of potash.

2618. Blood and Bone Animal Guano. Made and sampled by Thompson and Edwards Fertilizer Co. Guaranteed Nitrogen 5.4 per cent., phosphoric acid 11.4.

The manufacturers objected to the analysis of the first sample **2598,** alleging that it did not represent the brand they were then offering. They stated that they had changed their formula and that the new sample, **2618,** fairly represented the goods now sold in Connecticut. The analyses follow :

	2598	2618
Nitrogen as ammonia	.21	
Nitrogen, organic	2.37	7.36
Soluble phosphoric acid	.40	
Reverted phosphoric acid	6 56	8.97
Insoluble phosphoric acid	6.73	
Potash	.91	
Chlorine	.49	
Cost per ton	$36.00	
Valuation per ton	$25.23	31.82

The mechanical analysis of **2618** was as follows :

Fine, smaller than $\frac{1}{10}$ inch	48 per cent.
Fine medium, smaller than $\frac{1}{5}$ inch	29 "
Medium, smaller than $\frac{1}{2}$ inch	20 "
Coarse, larger than $\frac{1}{2}$ inch	3 "
	100 "

Dry Ground Fish.

2582. Pure Dry Ground Fish. Sold by Bowker Fertilizer Co., Boston. Sample drawn from stock of Carter and Strong, Manchester, price $40.00, and F. S. Bidwell, Windsor Locks, price $37.00. It contained 7.94 per cent. of nitrogen.

As the manufacturer's guarantee and the Station analysis refer alone to nitrogen this article is not included among the ammoniated superphosphates given on subsequent pages.

Mixed Fertilizers.

I. Nitrogenous Superphosphates and Guanos.

Here are included mixed fertilizers containing nitrogen, phosphoric acid and in most cases potash, which are not designed by their manufacturers for use on any special crops. "Special Manures" are noticed further on. Fish scrap is classified with these goods because it is sometimes acidulated with oil of vitriol to preserve it, thus making it a nitrogenous superphosphate.

1. *Samples drawn by Station Agents.*

In the tables on pages 77 to 89 are given fifty-eight analyses of this kind.

After the name of a brand the names of a number of dealers are frequently given. This indicates that a sample of this brand was drawn by our agent from each dealer named and that the corresponding analysis was made on a mixture of equal parts of all these samples.

The Station assumes full responsibility for accuracy of sampling and analysis only on such samples as are drawn by its own agents. On samples drawn by other persons the Station holds itself responsible only for the accuracy of analysis, but requires before making an analysis a formal statement that the person who drew the sample did it in accordance with the Station directions. A blank form for this statement is furnished on application.

Nitrogenous Superphosphates and Guanos Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.	Manufacturers' statement of average cash price per ton.
2647	Pure Bone Dissolved in Sulphuric Acid.	Mapes' Formula and Peruvian Guano Co., 158 Front St., N. Y.	Mapes' Branch, Hartford.	$33.00	$33.00
2588	Quinnipiac Dry Ground Fish.	Quinnipiac Co., New London.	H. K. Brainard, Thompsonville.	36.00	
			D. C. Wood, Stratford.	40.00	
			Manufacturer.	36.00	
			Olds & Whipple, Hartford.	38.00	
2556	Fish and Potash, Pequot Brand.	Quinnipiac Co., New London.	Martin Bros., Wallingford.	19.00	----
2573	Peruvian Guano.	Mapes' Formula and Peruvian Guano Co., 158 Front St., N. Y.	Mapes Branch, Hartford.	40.00	40.00
2557	Swift-Sure Superphosphate.	M. L. Shoemaker & Co., Phila., Pa.	F. Ellsworth, Hartford.	38.00	38.00
			J. P. Barstow & Co., Norwich.	37.00	
2464	Sanderson's Formula.	L. Sanderson, 87 Long Wharf, New Haven.	W. H. Hammond, Elliott. (Purchaser).	----	35.00
2555	Pine Island Phosphate.	Quinnipiac Co., New London.	E. B. Clark, Milford.	30.00	----
			Martin Bros., Wallingford.	30.00	
			Olds & Whipple, Hartford.	35.00	
2524	Fish and Potash, Anchor Brand.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	F. S. Bidwell, Windsor Locks.	31.00	31.00
			R. A. Parker, Warehouse Point.	33.00	
			W. B. Martin, Rockville.	35.00	
2585	Bowker's Fish and Potash.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	W. R. McDonald, Cromwell.	32.25	
			Carter & Strong, Manchester.	35.00	
			F. S. Bidwell, Windsor Locks.	31.00	
			J. H. Fish, Newington.	31.00	
2508	Cumberland Superphosphate.	Cumberland Bone Co., Portland, Me.	A. P. Smith, Lebanon.	35.00	----
			W. E. Wheeler, Jr., Mystic.	35.00	
			L. D. Post, Andover.	36.00	
2517	Complete Manure, for general use.	Mapes' Formula and Peruvian Guano Co., 158 Front St., N. Y.	Mapes Branch, Hartford.	39.00	39.00
			W. H. Childs, Manchester.	40.00	
			Southington Lumber and Feed Co., Southington.	38.00	

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.	Manufacturers' statement of average cash price per ton.
2553	Fish and Potash.	Orient Guano Mfg. Co., Orient, L. I.	E. A. Buck & Co., Willimantic.	$35.00	----
2604	Harvest Queen Phosphate.	H. S. Miller & Co., Newark, N. J.	Geo. W. Andrews, Naugatuck.	30.00	----
2621	Meyer's Acme Fertilizer, "E" Brand.	C. Meyer, Jr., Maspeth, L. I.	Gilbert Thompson, Essex.	34.00	
			A. N. Clark, Milford.	32.00	
			A. S. Russell & Co., Meriden.	33.00	
2510	Complete Manure, "A" Brand.	Mapes' Formula and Peruvian Guano Co., 155 Front St., N. Y.	Wilson & Burr, Middletown.	36.00	$36.00
			Birdsey & Foster, Meriden.	37.00	
			Mapes Branch, Hartford.	36.00	
2518	Standard Fertilizer.	Lister's Agricultural Chem. Works, Newark, N. J.	S. J. Hall, Meriden.	30.00	32.50
2484	Quinnipiac Phosphate.	Quinnipiac Co., New London, Ct.	R. W. Burchard, Darien.	38.00	----
			Jas. P. Little, Columbia.	36.00	
			J. M. Belden, New Britain.	36.00	
			Olds & Whipple, Hartford.	38.00	
			Chandler & Morse, Putnam.	34.00	
			W. W. Cooper, Suffield.	38.00	
			D. C. Wood, Stratford.	37.00	
			E. N. Pierce & Co., Plainville.	37.00	
			E. A. Godfrey, Southport.	36.00	
2520	Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	J. P. Barstow & Co., Norwich.	36.00	----
			Waldo Tillinghast, Plainfield.	36.00	
			W. W. Cooper, Suffield.	38.00	
2536	A. A. Ammoniated Superphosphate.	H. J. Baker & Bro., 215 Pearl St., N. Y.	Buckland & Hardin, Glastonbury.	37.50	----
			W. T. Gregory & Co., Milford.	37.50	
			E. J. Dickerman, Mt. Carmel.	36.75	
			D. N. Benton, Guilford.	36.00	
			W. F. Andross, East Hartford.	37.50	
			C. J. Porter, Goshen.	37.50	
			E. H. Talcott, Torrington.	36.00	
			J. H. Ives, Danbury.	37.50	

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.	Manufacturers' statement of average cash price per ton.
2479	Farmers' New Method Fertilizer.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	R. A. Parker, Warehouse Point.	$33.00	$32.00
			Prentiss & Young, Norwich.	32.00	
			F. S. Bidwell, Windsor Locks.	30.00	
			W. W. Cooper, Suffield.	33.00	
			D. N. Clark & Sons, Milford.	33.00	
2558	Fish and Potash.	Pacific Guano Co., Boston, Mass.	C. V. DeWolf, South Manchester.	32.00	27.00
			R. S. Woodford, Plainville.	30 00	
			H. A. Stillman, Hartford.	35.00	
			A. S. Russell & Co., Meriden.	35.00	
2522	Bradley's Sea Fowl Guano.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	W. W. Cooper, Suffield.	35.00	----
			F S. Bidwell, Windsor Locks.	32.00	
2600	Chittenden's Fish and Potash.	National Fertilizer Co., Bridgeport.	F. P. Burr & Co., Middletown.	35.00	----
			W. W. Cooper, Suffield.	35.00	
			T. H. Eldridge, Norwich.	35.00	
2545	Fish and Potash.	E. Frank Coe, 16 Burling Slip, N. Y.	W. T. Andrews, Orange.	29.00	----
2477	Bradley's Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	H. M. Rose, Milford.	38.00	35.00
			Waterbury & June, Greenwich.	38.00	
			C. A. Sharp, Abington.	38.00	
			R. A. Parker, Warehouse Point.	35.00	
			H. A. Merriam, Rocky Hill.	38.00	
			Dix & Welles, Wethersfield.	36.00	
			E. N. Pierce & Co., Plainville.	37.00	
			A. C. Sternberg, Hartford.	35.00	
			D. N. Clark & Sons, Milford.	37.00	
			Prentiss & Young, Norwich.	37.00	
			S. R. Woodward, Bethany.	36.00	
			F. S. Bidwell, Windsor Locks.	34.00	
			W. B. Martin, Rockville.	37.00	
			W. F. Andross, East Hartford.	37.50	
			Raymond Bros., South Norwalk.	35.00	
			Wheeler & Howe, Bridgeport.	37.00	

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.	Manufacturers' statement of average cash price per ton.
2482	High Grade Ammoniated Bone Superphosphate.	E. Frank Coe, 16 Burling Slip, N. Y.	I. W. Denison, Mystic.	$33.00	....
			Arnold Rudd, New London.	33.00	
			Backus Bros., South Windham.	....	
			J. P. Barstow & Co., Norwich.	32.00	
			G. H. Loomis, Chestnut Hill.	35.00	
			W. T. Andrews, Orange.	30.00	
			Hillhouse & Taylor, Willimantic.	38.00	
2543	Pelican Bone Phosphate.	H. J. Baker & Bro., 215 Pearl St., N. Y.	E. J. Dickerman, Mt. Carmel.	31.86	....
2509	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport.	L. W. Currier, Bridgeport.	40.00	....
			W. W. Cooper, Suffield.	42.00	
			D. G. Penfield, Danbury.	45.00	
			E. B. Clark, Milford.	39.00	
2514	Fish and Potash, Crossed Fishes Brand.	Quinnipiac Co., New London.	Olds & Whipple, Hartford.	37.00	....
			Martin Bros., Wallingford.	32.00	
			J. F. Silliman, New Canaan.	38.00	
			W. W. Cooper, Suffield.	35.00	
			E. N. Pierce & Co., Plainville.	35.00	
			M. O. Babcock, Branford.	35.00	
			B. E. Johnson, Higganum.	35.00	
2505	Soluble Pacific Guano.	Pacific Guano Co., Boston, Mass.	H. A. Stillman, Hartford.	35.00	$33.00
			W. F. Andross, East Hartford.	37.50	
			C. V. DeWolf, South Manchester.	38.00	
			A. S. Russell & Co., Meriden.	35.00	
			J. M. Belden, New Britain.	36.00	
			Abbott & Co., Birmingham.	38.00	
			S. B. Wheeler, Westport.	36.00	
2526	New Rival Phosphate.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Elliott Bros., Clinton.	26.00	....
			W. H. Scott & Co., Pequabuck.	35.00	

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.	Manufacturers' statement of average cash price per ton.
2546	Extra Bone Phosphate.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Geo. H. Loomis, Chestnut Hill.	$35.00	----
2504	Chittenden's Bone Superphosphate.	National Fertilizer Co., Bridgeport.	T. H. Eldridge, Norwich.	35.00	----
			E. B. Clark, Milford.	30.00	
			L. W. Currier, Bridgeport.	35.00	
			W. W. Cooper, Suffield.	35.00	
			D. G. Penfield, Danbury.	35.00	
			Waldo Tillinghast, Plainfield.	34.00	
			S. Griffiths, Moosup Valley.	40.00	
2533	Original Coe's Superphosphate of Lime.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Jas. P. Little, Columbia.	32.00	----
2559	Standard Fertilizer.	Standard Fertilizer Co., Boston, Mass.	A. P. Smith, Lebanon.	33.50	----
			Arnold Warren, Willimantic.	35.00	
2488	Americus Superphosphate.	Williams & Clark Co., 81 Fulton St., N. Y.	Dix & Welles, Wethersfield.	35.00	$35.00
			Jas. P. Little, Columbia.	36.00	
			H. K. Brainard, Thompsonville.	35.00	
			J. P. Barstow & Co., Norwich.	35.00	
			R. L. Bullard, Abington.	38.00	
			F. W. Martin, Clark's Corners.	34.00	
			W. E. Payne, Rockville,	35.00	
			A. M. Bowen, Eastford.	36.00	
2541	Superphosphate of Lime.	Chas. Prentice, Putnam.	R. S. Williams, Hampton.	34.00	----
2480	Ammoniated Dissolved Bone.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	E. B. Clark, Milford.	30.00	32.00
			W. H. Anderson, Putnam.	34.00	
			W. F. Andross, East Hartford.	33.00	
			H. A. Merriam, Rocky Hill.	33.00	
			Carter & Strong, Manchester.	33.00	
2544	Excelsior Red Brand Guano.	E. Frank Coe, 16 Burling Slip, N. Y.	D. N. Benton, Guilford.	40.00	----

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.	Manufacturers' statement of average cash price per ton.
2499	Bowker's Hill and Drill Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. A. Paine, Danielsonville.	$38.00	$36.00
			H. E. Mead, Ridgefield.	40.00	
			W. H. Anderson, Putnam.	36.00	
			F. Hallock & Co., Birmingham.	35.00	
			J. E. Leonard, Jewett City.	36.00	
			C. E. Guild, Hampton.	38.00	
			F. E. Fowler, Montville.	37.00	
2554	Orient Complete Manure.	Orient Guano Mfg. Co., Orient, L. I.	E. A. Buck & Co., Willimantic.	30.00	----
			G. W. Eaton, Bristol.	30.00	
			A. B. Morse, Guilford.	28.00	
2501	Ammoniated Bone Superphosphate.	Crocker Fertilizer and Chem. Co., Buffalo, N. Y.	R. S. Williams, Hampton.	34.00	----
			Chandler & Morse, Putnam.	34.00	
			H. K. Brainard, Thompsonville.	35.00	
			J. E. Leonard, Jewett City.	36.00	
			Waldo Tillinghast, Plainville.	39.00	
			S. B. Booth, Newtown.	37.00	
2516	Economical Fertilizer.	Wilkinson & Co., New York.	H. P. Treat, Orange.	32.00	30.00
2528	Alkaline Bone.	E. Frank Coe, 16 Burling Slip, N. Y.	F. H. Tillinghast, Central Village.	31.00	----
			E. C. Dennis, Stafford Springs.	30.00	
			Hillhouse & Taylor, Willimantic.	36.00	
2547	Ludlam's Cecrops Fertilizer.	Fred'k Ludlam. 140 Maiden Lane, N. Y.	A. L. Kuran, Tolland.	42.00	----
			R. S. Woodford, Plainville.	40.00	
			C. T. Leonard, Norwalk.	42.00	
			Starr & Bailey, Groton.	44.00	
2550	Davidge's Vegetator.	Davidge Fertilizer Co., 121 Front St., N. Y.	J. M. Burke, So. Manchester.	35.00	
			A. S. Hawkins, So. Coventry.	37.00	
2518	Fish and Potash, Plain Brand.	Quinnipiac Co., New London.	Olds & Whipple, Hartford.	33.00	
			C. S. Gillette, Cheshire.	28.00	
			H. K. Brainard, Thompsonville.	30.00	

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION—*Concluded.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.	Manufacturers' statement of average cash price per ton.
2563	Lion Special Fertilizer.	Reed Fertilizer Co., New York.	Edmund Halliday, Suffield.	$40.00	....
2630	Miles' I. X. L. Phosphate.	G. W. Miles, Agent, Milford.	W. E. Wheeler, Mystic.	30.00	....
			D. N. Clark & Son, Milford.	30.00	
			A. A. Hubbard, Canaan.	33.00	
2599	A. Mitchell's Standard Superphosphate.	A. Mitchell, Tremley, N. J.	Smalling Bros., Killingly.	37.00	....
					....
2561	Farmers' Friend Fertilizer.	Reed Fertilizer Co., New York.	Jas. Goldson. Warehouse Point.	35.00	....
2525	Davidge's Special Favorite.	Davidge Fertilizer Co., 121 Front St., N. Y.	C. A. McLean, Simsbury.	36.00	....
			J. M. Burke, So. Manchester.	34.00	
			A. S. Hawkins, So. Coventry.	35.00	
2562	High Grade Farmers' Friend.	Reed Fertilizer Co., New York.	Jas. Goldson, Warehouse Point.	42.00	....
2602	Ludlam's Cereal Fertilizer.	Fred'k Ludlam, 140 Maiden Lane, N. Y.	Jas. P. Little, Columbia.	32.00	....
			C. H. Cleveland, Brooklyn.	32.00	
2487	Ludlam's Cereal Fertilizer.	Fred'k Ludlam, 140 Maiden Lane, N. Y.	A. M. Bowen, Eastford.	36.00	....
			Starr & Bailey, Groton.	34.00	
			Prentiss & Young, Norwich.	33.00	
			R. S. Williams, Hampton.	32.00	
			C. T. Leonard, Norwalk.	34.00	
			R. L. Bullard, Abington.	35.00	....
2560	Reed's Lion Brand Superphosphate.	Reed Fertilizer Co., New York.	Edmund Halladay, Suffield.	32.00	
			W. F. Andross, East Hartford.	33.00	
2542	Bradley's Extra Fine Ground Bone with Potash.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Jas. P. Little, Columbia.	34.00	....
2552	Bradley's Fish and Potash, A Brand.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Dimond & Hawley, Bethel.	35.00	
			Burtis & Mead, New Canaan.	33.00	

Analyses of Nitrogenous Superphosphates Sampled by the Station.

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
2647	Mapes' Dissolved Bone	....	1.08	2.33	3.41	*2.0*	4.45	11.96	2.07	18.48	....	16.41	*12.0*	....	....	....	$33.00	$39.25	19.0*
2588	Quinnipiac Dry Ground Fish	....	....	8.68	8.68	*7.5*	.84	4.59	2.33	7.76	....	5.43	*4.0*	....	....	....	36.00	42.60	15.5*
2556	Quinnipiac Fish and Potash, Pequot Brand	....	.44	2.15	2.59	*2.5*	.32	3.70	3.12	7.14	....	4.02	*3.5*	4.59	*4.0*	7.28	19.00	21.90	13.2*
2578	Mapes' Peruvian Guano, No. 1	.06	2.25	.80	3.11	*3.3*	5.53	9.67	5.89	21.09	*22.0*	15.20	....	3 88	*4.0*	.59	40.00	43.09	7.1*
2557	Shoemaker's Swift Sure Superphosphate	.69	....	2.49	3.18	*2.5*	7.82	3.61	3.73	15.16	....	11.43	*9.0*	4.34	*4.0*	2.16	38.00	36.31	4.6
2464	Sanderson's Formula	.64	.06	2.54	3.24	*3.3*	6.30	1.63	2.24	10.17	*10.0*	7.93	*7.0*	7.24	*7.0*	4.51	35.00	32.82	6.7
2555	Quinnipiac Pine Island Phosphate	.58	.34	1.58	2.50	*2.0*	5.30	6.79	1.23	13.32	....	12.09	*9.0*	1.32	*1.0*	1.77	32.00	29.96	6.8
2524	Bradley's Fish and Potash, Anchor Brand	....	.12	3.32	3.44	*3.3*	5.34	1.78	1.76	8.88	*5.0*	7.12	....	3.81	*3.0*	7.37	31.00	28.78	7.7
2585	Bowker's Fish and Potash	....	....	2.47	2.47	*2.3*	6.65	1.72	3.46	11.83	*8.0*	8.37	....	4.47	*4.0*	4.75	31.00	28.71	7.9
2508	Cumberland Superphosphate	.53	.23	1.54	2.30	*2.0*	7 08	5.87	2.17	15.12	*12.0*	12.95	*9.0*	2.54	*2.0*	1.56	35.00	32.38	8.1
2517	Mapes' Complete Manure for General Use	....	.79	2.76	3.55	*3.3*	7.97	2.92	1.99	12.88	*10.0*	10.89	*8.0*	4.42	*4.0*	2.99	39.00	35.92	8.6
2553	Orient Fish and Potash	....	....	3.42	3.42	*3.3*	5.20	1.17	.78	7.15	....	6 37	*5.0*	9.60	*14.0*	8.50	35.00	32.19	8.7
2604	H. S. Miller's Harvest Queen Phosphate	....	....	1.76	1.76	*1.2*	9.80	1.61	.21	11.62	....	11.41	*10.0*	2.36	*1.5*	.64	30.00	27.49	9.2
2621	Meyer's Acme Fertilizer, E Brand	....	.72	1.79	2.51	*2.5*	4.40	4.12	1.99	10.51	....	8.52	*10.0*	4.90	*7.0*	.38	32.50	29.68	9.5
2510	Mapes' Complete Manure, "A" Brand	.51	.56	1.96	3.03	*2.5*	8.06	3.17	1.32	12.55	*12.0*	11.23	*10.0*	3.18	*2.5*	5.24	36.00	32.62	10.3
2518	Lister's Standard Fertilizer	....	.33	1.54	1.87	*1.2*	8.34	2.63	1.48	12.45	*10.0*	10.97	....	1.50	*1.5*	.18	30.00	27.01	11.0
2484	Quinnipiac Phosphate	.58	.41	2.05	3.04	*2.5*	6.15	5.82	1.14	13.11	....	11.97	*9.0*	1.89	*2.0*	1.58	36.00	32.27	11.6

* Valuation exceeds cost.

ANALYSES OF NITROGENOUS SUPERPHOSPHATES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrate.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
2520	Darling's Animal Fertilizer	....	.42	2.92	3.34	*3.3*	4.91	3.53	2.80	11.24	*10.0*	8.44	....	5.03	*4.0*	4.60	$36.00	$32.07	12.2
2536	Baker's "AA" Ammoniated Superphosphate	.09	2.02	.84	2.95	*2.5*	10.39	1.38	.85	12.62	*10.0*	11.77	....	2.80	*2.0*	2.96	37.00	32.91	12.4
2479	Bradley's Farmers' New Method Fertilizer	....	.12	1.90	2.02	*1.65*	8.40	2.20	1.17	11.77	*10 0*	10.60	....	3.52	*3.0*	3.36	32.00	28.29	13.1
2558	Pacific Guano Co., Fish and Potash	....	.28	2.25	2.50	*3.0*	5.14	3.51	2.38	11 03	*6.0*	8.65	*4.0*	4.90	*4.0*	5.33	33.00	28.83	14.4
2528	Bradley's Sea Fowl Guano	....	.63	1.75	2.38	*2.5*	8.12	2.91	1.97	13.00	*11 0*	11.03	*9 0*	1.83	*2.0*	2.00	33.50	29.23	14.6
2600	Chittenden's Fish and Potash	....	.29	2.92	3.21	*3.3*	.94	5.81	4.68	11.43	*6 0*	6.75	....	5.39	*5.0*	5.00	35.00	30.07	16.3
2545	E. F. Coe's Fish and Potash	....	....	2.47	2.47	*3.0*	6.03	1.80	1.68	9.51	*6.0*	7.83	*4.0*	2.19	*4.0*	3.83	29.00	24.72	17.3
2477	Bradley's Superphosphate	.27	1.57	.78	2.62	*2.3*	8.42	2.22	1.56	12.20	....	10.64	*9.0*	2.15	*1.5*	2.55	35.00	29.63	18.1
2482	E. Frank Coe's High Grade Ammoniated Bone Superphosphate	....	.67	1.58	2.25	*2.0*	9.11	1.27	1.57	11.95	*11.0*	10.38	....	2.37	*3.0*	.20	34.00	28.74	18.3
2543	Baker's Pelican Bone Phosphate	....	1.28	.75	2.03	*1.6*	8.07	1.51	1.30	10.88	....	9.58	*8.0*	2.47	*2.0*	5.79	31.00	25.90	19.6
2509	Chittenden's Complete Fertilizer	.18	....	3.09	3.27	*3.3*	5.48	4.80	3.26	13.54	*8.0*	10.28	....	5.24	*6.0*	5.00	42.00	35.00	20.0
2514	Quinnipiac Fish and Potash, Crossed Fishes Brand	....	.50	3.48	3.98	*3.5*	2.54	3.33	1.38	7.25	*5.0*	5.87	...	4.57	*3.0*	6 31	35.00	29.12	20.1
2505	Soluble Pacific Guano	....	.23	2.68	2.91	*2.3*	7.15	2.25	1.60	11.00	*10.5*	9.40	....	2.57	*2.0*	2.63	35.00	29.14	20.1
2526	Crocker's New Rival Phosphate	.09	....	1.42	1.51	*1.2*	8.49	2.08	.95	11.52	....	10.57	*10.0*	2.14	*3.0*	1.92	30.00	24.91	20.4
2546	Darling's Extra Bone Phosphate	....	.80	1.90	2.70	*2.5*	5.67	3.16	3.13	11.96	*10.0*	8.83	....	3.44	....	3.54	35.00	29.05	20.5

Analyses of Nitrogenous Superphosphates Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
2504	Chittenden's Bone Superphosphate	....	....	2.22	2.22	*1.6*	6.84	4.16	2.24	13.24	*10.0*	11.00	*8.0*	2.29	*2.0*	2.04	$35.00	$29.02	20.6
2533	Original Coe's Superphosphate of Lime	....	....	2.20	2.20	*2.1*	7.71	2.04	2.00	11.75	*10.0*	9.75	*8.0*	1.72	*1.0*	1.64	32.00	26.51	20.7
2559	Standard Fertilizer	....	....	1.99	1.99	*2.0*	7.71	2.65	2.77	13.13	*10.0*	10.36	*8.0*	2.04	*2.0*	2.18	33.50	27.38	22.3
2488	Williams & Clark's Americus Superphosphate	....	.91	1.46	2.37	*2.0*	9.25	1.66	.15	11.06	*11.0*	10.91	*10.0*	2.45	*2.0*	2.00	35.00	28.60	22.3
2541	Chas. Prentice's Superphosphate of Lime	....	1.09	1.09	2.18	*2.0*	3.02	5.56	6.34	14.92	....	8.58	....	2.78	*2.0*	2.62	34.00	27.77	22.5
2480	Bowker's Ammoniated Dissolved Bone	.47	1.20	.29	1.96	*2.0*	7.89	1.88	2.76	12.53	*11.0*	9.77	*10.0*	1.95	*2.0*	3.46	32.00	26.11	22.6
2544	E. Frank Coe's Excelsior Red Brand Guano	....	.76	2.48	3.24	*1.0*	7.60	.79	1.04	9.43	*10.0*	8.39	*7.0*	5.53	*11.0*	.74	40.00	32.56	22.8
2499	Bowker's Hill and Drill Phosphate	.68	....	2.05	2.73	*2.5*	7.67	2.66	2.42	12.75	*12.0*	10.33	....	1.75	*2.0*	1.80	36.00	29.29	22.9
2554	Orient Complete Manure	....	.29	1.39	1.68	*1.6*	7.83	1.78	.76	10.37	*7.0*	9.51	*8.0*	1.55	*1.0*	1.53	29.00	23.44	23.7
2501	Crocker's Ammoniated Bone Superphosphate	....	....	3.00	3.00	*2.9*	7.55	2.17	1.80	11.52	*8.0*	9.72	*8.0*	1.40	*1.0*	1.47	36.00	29.08	23.8
2516	Wilkinson's Economical Fertilizer	....	....	1.67	1.67	*1.6*	7.72	2.44	1.48	11.64	*7.0*	10.16	....	2.11	*3.0*	.25	32.00	25.69	24.6
2528	E. Frank Coe's Alkaline Bone	....	....	1.15	1.15	*1.0*	9.14	1.99	1.92	13.05	....	11.13	*9.0*	1.86	*1.8*	.27	32.00	25.25	26.7
2547	Ludlam's Cecrops Fertilizer	.65	.46	1.94	3.05	*3.3*	7.48	1.94	1.46	10.88	....	9.42	*7.0*	6.33	*7.0*	6.43	42.00	32.79	28.0
2518	Quinnipiac Fish and Potash, Plain Brand	....	.51	2.64	3.15	*2.0*	.89	3.16	1.89	5.94	*6.0*	4.05	....	4.06	*4.0*	5.84	30.00	22.91	30.9
2550	Davidge's Vegetator	....	1.08	2.18	3.26	*2.9*	5.28	.87	1.16	7.31	*6.0*	6.17	*5.0*	4.08	*4.0*	4.25	35.00	26.51	32.0

Analyses of Nitrogenous Superphosphates Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
2563	Reed's Lion Special Fertilizer	....	....	2.78	2.78	*2.5*	6.50	2.29	1.14	9.93	*10.0*	8.79	*8.0*	5.49	*10.0*	5.67	$40.00	$30.02	33.2
2630	Miles' I. X. L. Phosphate	....	.63	1.45	1.98	*2.0*	5.69	2.25	3.36	11.30	....	7.94	*8.0*	1.26	*1.0*	.93	31.00	23.14	33.9
2599	Mitchell's Standard Superphosphate	.32	.28	1.22	1.82	*2.5*	8.84	2.56	.37	11.77	....	11.40	*9.0*	1.89	*2.5*	....	37.00	27.26	35.7
2561	Reed's Farmers' Friend Fertilizer	....	....	2.14	2.14	*2.1*	6.84	2.72	1.64	11 20	*11.0*	9.56	*9.0*	1.86	*4.0*	2.31	35.00	25.80	35.7
2525	Davidge's Special Favorite	....	....	1.52	1.52	*1.2*	8.51	2.17	1.03	11.71	*11.0*	10.68	*10.0*	1.63	*1.5*	1.41	34.00	24.75	37.4
2562	Reed's High Grade Farmers' Friend Fertilizer	....	.29	3.09	3.38	*3.3*	3.68	1.32	1.23	6.23	*6.0*	5.00	*5.0*	10.01	*10.0*	8.68	42.00	30.46	37.8
2602	Ludlam's Cereal Fertilizer	....	....	1 09	1.09	*1.2*	7.48	2.09	4.09	13.66	*11.0*	9.57	*10.0*	1.43	*4.0*	3.39	32.00	22.98	39.2
2487	Ludlam's Cereal Fertilizer	.22	....	.75	.97	*1.2*	8.85	1.36	2.76	12.97	*11.0*	10.21	*10.0*	1.66	*4.0*	4.21	32.00	22.95	39.4
2560	Reed's Lion Brand Superphosphate	....	....	1.16	1.16	*.8*	6.57	1.65	1.15	9.37	*10.0*	8.12	*8.0*	3.90	*8.0*	5.03	32.00	21.67	47.6
2542	Bradley's Extra Fine Ground Bone with Potash	.08	.29	1.60	1.97	*1.9*	2.45	4.00	4.35	10.80	*9.1*	6.45	....	2.21	*2.0*	5.95	34.00	21.97	54.8
2552	Bradley's Fish and Potash, A Brand	....	.18	2.41	2.59	*2.0*	1.94	1.50	1.99	5.43	*6.0*	3.44	....	4.31	*4.0*	9.46	34.00	20.26	67.8

Fish and Potash.—Sampled by the Station.

	Quinnipiac Pequot.	Bradley's Anchor Brand.	Bowker's.	Orient.	Pacific Guano Co's.	Chittenden's.	Coe's.	Quinnipiac, Crossed Fishes Brand.	Quinnipiac, Plain Brand.	Bradley's A Brand.
	2556	2524	2535	2553	2558	2600	2545	2514	2513	2552
Nitrogen as Ammonia	.44	.12	....	....	.28	.29	....	.50	.51	.18
Nitrogen, Organic	2.15	3.32	2.47	3.42	2.25	2.92	2.47	3.48	2.64	2.41
Soluble Phosphoric Acid	.32	5.34	6.65	5.20	5.14	.94	6.03	2.54	.89	1.94
Reverted Phosphoric Acid	3.70	1.78	1.72	1.17	3.51	5.81	1.80	3.33	3.16	1.50
Insoluble Phosphoric Acid	3.12	1.76	3.46	.78	2.38	4.68	1.68	1.38	1.89	1.99
Potash	4.59	3.81	4.47	9.60	4.90	5.39	2.19	4.57	4.06	4.31
Cost	$19.00	$31.00	$31.00	$35.00	$33.00	$35.00	$29.00	$35.00	$30.00	$34.00
Valuation	$21.90	$28.78	$28.71	$32.19	$28.83	$30.07	$24.72	$29.12	$22.91	$20.26
Nitrogen found	2.59	3.44	2.47	3.42	2.50	3.21	2.47	3.98	3.15	2.59
Nitrogen guaranteed	2.5	3.3	2.3	3.3	3.0	3.3	3.00	3.5	2.0	2.0
Phosphoric Acid found	7.14	8.88	11.83	7.15	11.03	11.43	9.51	7.25	5.94	5.43
Phosphoric Acid guaranteed	....	5.00	8.0	....	6.0	6.0	6.0	5.0	6.0	....
Potash found	4.59	3.81	4.47	9.60	4.90	5.39	2.19	4.57	4.06	4.31
Potash guaranteed	4.0	3.0	4.0	14.0	4.0	5.0	4.0	3.0	4.0	4.0

Analyses of Manufacturers' Samples of Nitrogenous Superphosphates.

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Valuation per Ton.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.		
2566	Crocker Fertilizer & Chemical Co's Queen City Phosphate	....	....	1.89	1.89	*1.7*	7.13	2.02	.48	9.63	....	9.15	*8.0*	2.56	*1.0*	2.18	$24.21
2567	Crocker Fertilizer & Chemical Co's Superphosphate, No. 2	....	....	....	....	....	9.99	2.71	.83	13.53	....	12.70	*11.0*	2.62	*1.0*	2.44	22.90
2564	Crocker Fertilizer & Chemical Co's Vegetable Bone Superphosphate	1.20	.29	3.03	4.52	*5.0*	3.61	2.37	1.82	7.80	....	5.98	*6.0*	9.45	*6.0*	8.11	35.63
2570	E. R. Kelsey's Fish and Potash	....	.70	3.13	3.83	....	2.14	2.20	.10	4.44	....	4.34	....	3.47	....	.33	25 28
2572	Lister Fertilizer Chemical Works' Ammoniated Dissolved Bone	....	.44	1.81	2.25	....	6.62	3.19	2.34	12.15	....	9.81	....	1.68	....	trace	27.34
2489	G. W. Miller's Flour of Bone Phosphate	.84	.49	3.56	4.89	....	.32	4.22	3.07	7.61	....	4.54	....	6.79	....	6.15	33.04
2571	Standard Fertilizer Co's Standard Guano	....	....	1.57	1.57	*1.0*	6.96	2.12	2.83	11.91	*10.0*	9.08	*8.0*	2.39	*2.0*	2.19	24.14
2616	Williams & Clark Co's Royal Bone Phosphate	....	....	1.37	1.37	*.9*	6 38	1.76	.39	8.53	*8.0*	8.14	*8.0*	1.98	*2.0*	2.02	20.07
2615	Williams & Clark Co's Universal Dissolved Bone	....	....	1.88	1.88	*1.7*	6.95	1.83	.32	9.10	*10.0*	8.78	*8.0*	1.97	*2.0*	.34	23.42

Early in the year a circular was sent to all manufacturers whose goods were sold in Connecticut, asking them to inform the Station what would be about the average cash price of their goods in this State during the coming season. In the tables with the various *dealers'* quotations is also given for comparison the *manufacturers'* statement of the average retail cash price per ton in the State in cases where the manufacturer supplied such statement. The cash prices are usually about five per cent. lower than the credit or "time" prices.

The retail cash price of the same fertilizer as quoted by different dealers varies in some cases considerably, partly on account of differences in freight-rates, presence or absence of competition, etc. Some manufacturers arrange with their selling agents so that a given brand shall be sold at a uniform price at all points in the State, but usually the price charged is fixed by the dealer.

The last column of the table of analyses is "Percentage Difference between Cost and Valuation." Its significance and the method of calculating it may be seen by noticing the fifth analysis in the table on page 84, No. 2557. Here the cost is $38, the valuation is $36.31, and the difference between them is $2.69. By multiplying this difference, $2.69, by 100, and dividing it by the valuation, $36.31, we get 4.6, the percentage advance of selling price over valuation, which advance should represent on the average the costs and profits of the manufacturer in converting the raw materials into a mixed fertilizer, selling it and collecting on his sales.

DIFFERENCE BETWEEN COST AND VALUATION.

Leaving out of account the last two analyses in the tables in which the cost exceeded valuation by more than 50 per cent. the average cost of 56 nitrogenous Superphosphates was $34.10 and the average valuation $29.10. The difference is $5.00, and the percentage difference 17.2.

That is, the same quantities of nitrogen, phosphoric acid and potash, which were contained in an average ton of Nitrogenous Superphosphate could have been bought in raw materials of standard quality in ton lots in this State for $29.10 cash, in the average Superphosphate they cost $34.10, and hence the manufacturers' and dealers' expenses and profits on a ton of fertilizer averaged $5.00, or 17.1 per cent. of the cost of the materials.

The percentage difference between cost and valuation has been smaller this year than in any year since the present system of valuation has been used, as the following table shows:

Year.	Average Cost.	Average Valuation.	Percentage Difference.
1889	$34.10	$29.10	17.1
1888	34.55	28.79	2.02
1887	35.74	28.44	25.6
1886	36.58	29.42	24.3
1885	37.60	30.47	23.4
1884	40.73	33.13	22.9

Guarantees.—The analyses of 23 superphosphates out of the 58 show that their composition is below the maker's minimum guarantee in one or more particulars. Thirteen are deficient in one ingredient, eight in two and two in all the three ingredients. In most cases the deficiency is due to a misleading, and in this State illegal, method of expressing the guarantee of potash.

It is required, under the law, that the quantity of *actual* potash shall be expressly stated. "Potash, Sulphate, 4 per cent." means four per cent. of *actual potash* in the form of sulphate, and not 2.16 per cent. of potash, but the expression is often used by manufacturers, when only the smaller quantity of actual potash is present in the fertilizer. Such use is deceptive.

Fish and Potash.—The analyses of this material which in past years has been a favorite fertilizer in this State, though included among nitrogenous superphosphates are also tabulated by themselves on page 88. Most of the brands are not simple mixtures of fish scrap and potash salts, as the name would imply, but contain added phosphates and in one case, No. **2600**, more than 4.5 per cent. of insoluble phosphoric acid.

Notes on particular analyses.—The analysis of Ludlam's Cereal Fertilizer No. **2487** having been unsatisfactory to the manufacturer another analysis was made, No. **2602**, on different samples collected by our Agents. The two analyses given in the tables show substantial agreement.

2. *Manufacturers' Samples.*

The fertilizers named below were not found by the Station agents in any stocks which they inspected, and accordingly the analyses were made on samples deposited at the Station by manufacturers.

2566. Queen City Phosphate, made by the Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

2567. Crocker's Superphosphate, No. 2, made by the Crocker Fertilizer & Chemical Co., Buffalo, N. Y.

2564. Crocker's Vegetable Bone Superphosphate, made by the Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

2570. Kelsey's Fish and Potash, made by E. R. Kelsey, Branford, Conn.

2572. Lister's Ammoniated Dissolved Bone, made by Lister's Fertilizer Chemical Works, Newark, N. J.

2489. Flour of Bone Phosphate, made by G. W. Miller, Middlefield, Conn.

2571. Standard Guano, made by the Standard Fertilizer Co., Boston, Mass.

2616. Royal Bone Phosphate, made by Williams & Clark Co., 81 Fulton Street, N. Y.

2615. Universal Dissolved Bone, made by Williams & Clark Co., 81 Fulton Street, N. Y.

II. Special Manures, sampled by Station Agents.

For Analyses and Valuations see pages 93–99.

Here are included such Nitrogenous Superphosphates as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

Guarantees.—Of the thirty samples analyzed fifteen are below the maker's minimum guarantee as regards one ingredient and two are below guarantee on two ingredients.

COST AND VALUATION.—In four cases the valuation exceeded the cost.

The average cost of 30 special manures has been $40.25 and the average valuation $35.20. The difference between cost and valuation has been $5.05 and the Percentage Difference 14.3. The corresponding difference in case of the superphosphates (see page 90) was 17.1 per cent.

This year, as heretofore, the Special Manures as a class have been higher-priced and more concentrated than the other nitrogenous superphosphates, and if the quality of the raw materials composing them is equally good, more economical to purchase.

The percentage difference between cost and valuation has been less the last year than in any year since 1884, when the present system of valuation was adopted, as the following statement shows :—

Special Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.	Manufacturers' statement of average cash price per ton.
2427	Fairchild's Formula for Seeding Down.	The Rogers & Hubbard Co., Middletown.	Manufacturer.	$40.00	$40.00
2432	The Rogers & Hubbard Co's Complete Potato and Tobacco Manure.	The Rogers & Hubbard Co., Middletown.	Manufacturer.	47.50	47.50
2433	Fairchild's Formula for Corn and General Crops.	The Rogers & Hubbard Co., Middletown.	Manufacturer.	46.00	46.00
2540	Fruit and Vine Manure.	Mapes' Formula & Peruvian Guano Co., 158 Front St., New York.	Mapes' Branch, Hartford.	38.00	38.00
2503	Mapes' Corn Manure.	Mapes' Formula & Peruvian Guano Co., 158 Front St., N. Y.	Dean & Horton, Stamford.	42.00	41.00
			A. W. Northrop, Ridgefield.	43.00	
			Birdsey & Foster, Meriden.	42.00	
			S. Griffiths, Moosup Valley.	43.00	
			Wilson & Burr, Middletown.	41.00	
			Mapes' Branch, Hartford.	41.00	
			Geo. K. Nason, Willimantic.	42.00	
			J. P. Barstow & Co., Norwich.	42.00	
2548	Grass and Grain Spring Top Dressing	Mapes' Formula & Peruvian Guano Co., 158 Front St., New York.	Mapes' Branch, Hartford.	41.00	41.00
			C. A. McLean, Simsbury.	43.00	
2549	Tobacco Manure. Wrapper Brand.	Mapes' Formula & Peruvian Guano Co., 158 Front St., New York.	Mapes' Branch, Hartford.	48.00	48.00
			C. A. McLean, Simsbury.	50.00	
2551	Complete Manure for Light or Sandy Soil.	Mapes' Formula & Peruvian Guano Co., 158 Front St., New York.	Mapes' Branch, Hartford.	44.00	44.00
			J. P. Barstow & Co., Norwich.	45.00	
2603	Special Potato Manure.	H. S. Miller & Co., Newark, N. J.	R. W. Cowles, Plantsville.	40.00	----
2522	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	G. A. Dickinson, Haddam.	42.00	40.00
			Jas. P. Little, Columbia.	40.00	
			J. E. Holmes, Stratford.	42.00	

Special Manures Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.	Manufacturers' statement of average cash price per ton.
2483	Potato Manure.	Mapes' Formula & Peruvian Guano Co., 158 Front St., New York.	Mather & Granman, Darien.	$45.00	$43.00
			F. Hallock & Co., Birmingham.	45.00	
			Wheeler & Howe, Bridgeport.	45.00	
			Abbott & Co., Birmingham.	46.00	
			Mapes' Branch, Hartford.	43.00	
			E. N. Pierce & Co., Plainville.	43.00	
			Geo. K. Nason, Willimantic.	44.60	
			Wilson & Burr, Middletown.	43.00	
2506	Potato Manure.	H. J. Baker & Bro., 215 Pearl St., New York.	A. L. Winton, Bridgeport.	42.50	----
			W. W. Cooper, Suffield.	42.50	
2648	Mapes' Complete Manure for Heavy Soils.	Mapes' Formula & Peruvian Guano Co., 158 Front St., New York.	Mapes' Branch, Hartford.	44.00	44.00
			M. T. Gregory & Co., Milford.	42.50	
			E. F. Hawley, Newtown.	42.50	
2531	Special Corn Manure.	H. J. Baker & Bro., 215 Pearl St., New York.	Strong & Tanner, Winsted.	42.00	----
			W. W. Cooper, Suffield.	42.50	
2486	Potato Manure.	Quinnipiac Co., New London.	Manufacturer.	34.00	----
			D. C. Wood, Stratford.	38.00	
			E. N. Pierce & Co., Plainville.	38.00	
			J. M. Belden, New Britain.	39.00	
			Jas. P. Little, Columbia.	38.00	
			E. A. Godfrey, Southport.	37.00	
			Olds & Whipple, Hartford.	40.00	

Special Manures Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.	Manufacturers' statement of average cash price per ton.
2622	Meyer's Acme Potato Manure.	C. Meyer, Jr., Maspeth, L. I.	A. N. Clark, Milford.	$38.00	----
2530	Complete Manure for Corn and Grain.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Strong & Tanner, Winsted.	42.00	40.00
2478	Bradley's Potato Manure.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	R. A. Parker, Warehouse Point.	38.00	----
			D. N. Clark & Sons, Milford.	37.00	
			F. S. Bidwell, Windsor Locks.	35.00	
			S. R. Woodward, Bethany.	37.00	
			H. M. Rose, Milford.	38.00	
			W. W. Cooper, Suffield.	36.00	
			W. F. Andross, East Hartford.	38.00	
			Rob't Payne, Woodbridge.	37.00	
			E. N. Pierce & Co., Plainville.	38.00	
			Prentiss & Young, Norwich.	----	
			Waterbury & June, Greenwich.	40.00	
			James P. Little, Columbia.	38.00	
2502	Potato, Hop and Tobacco Fertilizer.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	J. E. Leonard, Jewett City.	36.00	----
			H. K. Brainard, Thompsonville.	36.00	
			Wm. C. Russell, Orange.	36.00	
			R. S. Williams, Hampton.	36.00	
			J. M. Belden, New Britain.	38.00	
			E. N. Pierce & Co., Plainville.	36.00	

Special Manures Sampled by the Station—*Concluded.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.	Manufacturers' statement of average cash price per ton.
2481	Stockbridge Vegetable Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	R. W. Burchard, Darien.	$42.50	----
			Carter & Strong, Manchester.	43.00	
			F. Hallock & Co., Birmingham.	39.00	
			W. H. Anderson, Putnam.	42.50	
			J. E. Leonard, Jewett City.	42.00	
			A. P. Smith, Lebanon.	38.00	
			F. S. Bidwell, Windsor Locks.	42.00	
			C. H. Smith, Columbia.	40.00	
			E. B. Clark, Milford.	40.00	
			W. R. McDonald, Cromwell.	41.00	
			C. E. Guild, Hampton.	41.00	
2521	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	John Brun, Naugatuck.	38.00	----
			E. N. Pierce & Co., Plainville.	36.00	
			Wm. C. Russell, Orange.	34.00	
2507	Stockbridge Grass Manure or Top Dressing.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	F. S. Bidwell, Windsor Locks.	42.00	----
			Carter & Strong, Manchester.	43.00	
			W. H. Anderson, Putnam.	42.50	
			J. A. Paine, Danielsonville.	42.50	
2532	Stockbridge Vegetable Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	W. H. Anderson, Putnam.	42.50	----
			F. C. Hull, South Coventry.	43.00	
2519	Great Eastern Vegetable, Vine and Tobacco Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	W. A. Snow, Columbia.	35.00	----
			F. W. Goodrich, Portland.	35.00	
			G. T. Sanger, Canterbury.	35.00	

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.	Manufacturers' statement of average cash price per ton.
2500	Stockbridge Corn Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. A. Paine, Danielsonville.	$42.50	....
			Carter & Strong, Manchester.	43.00	
			H. E. Mead, Ridgefield.	45.00	
			C. E. Guild, Manchester.	41.00	
			F. S. Bidwell, Windsor Locks.	42.00	
			W. H. Anderson, Putnam.	42.50	
			H. A. Merriam, Rocky Hill.	42.00	
			F. C. Fowler, Montville.	39.00	
			W. R. McDonald, Cromwell.	42.50	
2613	Williams & Clark's Potato Phosphate.	Williams & Clark Co., 81 Fulton St., New York.	H. K. Brainard, Thompsonville.	36.00	....
			J. P. Barstow & Co., Norwich.	36.00	
			Atwood & Wilson, Watertown.	38.00	
			R. H. Hall, East Hampton.	38.00	
			S. Griffiths, Moosup Valley.	37.00	
			F. W. Martin, Clark's Corners.	34.00	
2515	Grain and Grass Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	Wade A. Snow, Columbia.	35.00	....
			G. T. Sanger, Canterbury.	35.00	
2608	Potato Manure.	Davidge Fertilizer Co., 121 Front St., New York.	F. F. Hitchcock, Woodbury.	42.00	....
			W. B. Coan, Long Hill.	40.00	
			W. P. Bartholomew, Bantam.	40.00	
			S. H. Daggett, Andover.	40.00	
			George Boughton, Ridgebury.	40.00	
			G. H. Platt, Redding Ridge.	34.20	
2534	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	E. E. Cooley, Simsbury.	38.00	....
2529	Potato Fertilizer.	E. F. Coe, Burling Slip, New York.	John Amidon & Co., Wethersfield.	40.00	....

Analyses of Special Manures Sampled by the Station.

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
2437	Fairchild's Formula for Seeding Down	....	...	2.89	2.89	*2.5*	....	....	....	18.54	*17.5*	....	....	13.12	*12.5*	10.00	$40.00	$45.30	11.7*
2432	Rogers & Hubbard Co's Complete Potato and Tobacco Manure	3.16	....	2.24	5.40	*5.0*	....	....	....	15.74	*14.5*	....	....	9.89	*10.0*	none	47.50	50.82	6.5*
2433	Fairchild's Formula for Corn and General Crops	3.13	....	2.30	5.43	*5.5*	....	....	....	14.63	*12.5*	....	....	11.61	*12.5*	8.70	46.00	47.60	3.4*
2540	Mapes' Fruit and Vine Manure	.39	.57	1.66	2.62	*1.6*	7.72	1.61	.90	10.23	*7.0*	9.33	....	10.30	*11.0*	none	38.00	37.47	1.4
2503	Mapes' Corn Manure	.93	1.32	1.71	3.96	*3.7*	7.89	3.23	1.55	12.67	*10.0*	11.12	....	6.58	*7.0*	5.89	41.00	39.00	5.1
2548	Mapes' Grass and Grain Spring Top Dressing	1.13	1.68	1.81	4.62	*4.1*	5.93	3.45	2.65	12.03	*7.0*	9.38	*5.0*	5.97	*5.0*	5.08	41.00	38.73	5.8
2549	Mapes' Tobacco Manure, Wrapper Brand	.65	4.17	1.47	6.29	*6.2*	1.89	2.51	1.55	5.95	*4.5*	4.40	....	11.71	*10.5*	1.24	48.00	44.92	6.8
2551	Mapes' Complete Manure for Light or Sandy Soil	.85	2.21	2.44	5.50	*4.9*	5.94	2.82	1.48	10.24	*7.0*	8.76	....	6.40	*6.0*	6.45	44.00	40.93	7.5
2603	H. S. Miller's Special Potato Manure	....	....	4.22	4.22	*3.7*	6.57	.58	.23	7.38	....	7.15	*5.5*	7.71	*7.0*	trace	40.00	36.82	8.7
2522	Bradley's Complete Manure for Potatoes and Vegetables	.47	.34	2.96	3.77	*3.7*	8.25	2.14	.79	11.18	*9.0*	10.39	*8.0*	5.61	*6.0*	5.54	40.00	36.07	10.9
2483	Mapes' Potato Manure	1.08	1.25	1.50	3.83	*3.7*	6.12	3.40	1.95	11.47	*8.0*	9.52	*8.0*	7.17	*6.0*	.38	43.00	38.63	11.3
2506	Baker's Potato Manure	....	2.82	1.21	4.03	*3.3*	6.66	1.32	.72	8.70	....	7.98	*5.8*	9.39	*10.0*	3.94	42.50	38.08	11.6
2648	Mapes' Complete Manure for Heavy Soils	.86	1.85	2.07	4.78	*4.9*	6.94	3.08	2.93	12.95	*10.0*	10.02	....	3.29	*3.0*	.31	44.00	39.13	12.5
2531	Baker's Special Corn Manure	....	3.78	.87	4.65	*4.9*	6.61	1.04	.96	8.61	....	7.65	*6.3*	7.87	*7.0*	8.28	42.50	37.47	13.4
2486	Quinnipiac Potato Manure	.74	.44	2.33	3.51	*2.5*	3.60	4.22	1.20	9.02	....	7.82	*6.0*	5.98	*5.0*	.59	38.00	32.79	15.8

* Valuation exceeds cost. A mixture of bone and chemicals. Nitrogen and Phos. acid valued as in bone, not as in Superphosphates.

Analyses of Special Manures Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
2622	Meyer's Acme Potato Manure	....	1.58	1.07	2.65	*2.9*	3.83	3.77	1.49	9.09	*7.0*	7.60	....	8.92	*9.0*	3.99	$38.00	$31.86	19.2
2530	Bradley's Complete Manure for Corn and Grain	.38	.53	2.21	3.12	*3.3*	7.89	2.25	1.17	11.31	*10.0*	10.14	*8.0*	5.33	*4.5*	5.31	40.00	33.19	20.5
2478	Bradley's Potato Manure	....	.12	2.54	2.66	*2.5*	6.25	2.00	2.33	10.58	*8.0*	8.25	*6.0*	5.16	*5.0*	3.73	36.00	29.21	23.2
2502	Crocker's Potato, Hop and Tobacco Fertilizer	....	....	2.12	2.12	*2.0*	8.72	2.09	.78	11.59	*8.0*	10.81	....	3.98	*3.5*	3.79	36.00	29.20	23.2
2481	Stockbridge Vegetable Manure	.58	.71	1.83	3.12	*3.2*	7.29	2.19	1.58	11.06	*8.0*	9.48	*7.0*	6.45	*5.0*	6.68	41.00	33.23	23.4
2521	Crocker's Ammon. Wheat and Corn Phosphate	....	....	2.47	2.47	*2.0*	8.96	1.83	.64	11.43	....	10.79	*10.0*	2.33	*1.8*	1.26	36.00	29.15	23.5
2507	Stockbridge Grass Manure for Top Dressing	2.37	....	2.02	4.39	*5.0*	5.21	1.91	3.48	10.60	*6.0*	7.12	*3.0*	4.72	*5.0*	4.75	41.00	33.20	23.5
2532	Stockbridge Vegetable Manure	.20	1.09	1.93	3.22	*3.2*	7.34	2.17	1.47	10.98	*8.0*	9.51	*7.0*	5.59	*5.0*	5.37	41.00	33.06	24.0
2519	Great Eastern Vegetable, Vine and Tobacco Fertilizer	....	.21	1.91	2.12	*2.1*	6.34	2.50	1.61	10.45	....	8.84	*8.0*	5.84	*6.0*	5.00	35.00	28.18	24.2
2500	Stockbridge Corn Manure	1.03	....	2.32	3.35	*3.2*	6.06	3.85	2.87	12.78	*9.0*	9.91	*8.0*	3.45	*4.0*	3.62	41.00	32.63	25.6
2613	Williams & Clark Co's Potato Phosphate	....	.94	1.54	2.48	*2.0*	6.76	1.00	.22	7.98	*8.0*	7.76	*7.0*	5.83	*6.0*	3.53	36 00	27.46	31.1
2515	Great Eastern Grain and Grass Fertilizer	....	....	2.63	2.63	*2.9*	6.65	2.34	1.32	10.31	....	8.99	*8.0*	1.87	*2.0*	1.98	35.00	26.61	31.5
2608	Davidge's Potato Manure	....	.85	2.15	3.00	*2.9*	7.58	1.84	1.26	10.68	*10.0*	9.42	*9.5*	3.67	*4.5*	4.06	40.00	30.35	31.8
2534	Crocker's Ammon. Wheat and Corn Phosphate	....	....	2.47	2.47	*2.0*	8.61	1.88	.77	11.26	....	10.49	*10.0*	2.41	*1.8*	2.26	38.00	28.62	32.8
2529	E. Frank Coe's Potato Manure	....	....	2.05	2.05	*2.0*	7.58	1.40	1.32	10.30	....	8.98	*8.0*	5.09	*6.0*	2.36	38.00	27.98	35.7

Year.	Average Cost.	Average Valuation.	Percentage Difference.
1889	$40.25	$35.20	14.3
1888	39.47	33.99	16.1
1887	42.52	35.20	20.9
1886	42.56	36.70	16.0
1885	44.80	38.70	16.0
1884	49.95	44.20	13.0

2. *Manufacturers' Samples.*

The brands named below were not found in any stock inspected by the station agents and the analyses were therefore made on samples deposited by manufacturers in accordance with the requirements of the fertilizer law.

2565. Crocker's Special Potato Manure, made by Crocker Fertilizer & Chemical Co., Buffalo, N. Y.

2568. Cumberland Seeding Down Fertilizer, made by the Cumberland Bone Co., Portland, Maine.

2569. Great Eastern General Fertilizer for Oats, Buckwheat and Seeding Down, made by the Great Eastern Fertilizer Co., Rutland, Vt.

2617. Williams & Clark's Americus Brand Tobacco Fertilizer, made by Williams & Clark Co., 81 Fulton street, N. Y.

ANALYSES AND VALUATIONS.

	2565	2568	2569	2617
Nitrogen as nitrates	1.85	.32	---	----
Nitrogen as ammonia	.25	.40	----	1.19
Organic nitrogen	1.39	1.06	.98	2.37
Total nitrogen found	3.49	1.78	.98	3.56
Nitrogen guaranteed	3.7	1.7	.9	4.1
Soluble phosphoric acid	5.75	1.95	7.11	5.73
Reverted phosphoric acid	2.78	4.56	1.41	.65
Insoluble phosphoric acid	1.40	16.90	.76	.14
Total phosphoric acid found	9.93	23.41	9.28	6.52
Phosphoric acid guaranteed	----	18.0	----	6.0
Available phosphoric acid found	8.53	6.41	8.52	6.38
Available phosphoric acid guaranteed	8.0	----	8.0	5.0
Potash found	6.61	.21	3.95	6.85
Potash guaranteed	5.5	1.0	4.0	8.0
Chlorine	5.98	.46	6.97	2.75
Valuation per ton	$32.68	23.55	21.24	30.88

HOME-MIXED FERTILIZERS.

Following are analyses of all the samples of Home-mixed Fertilizers which have been sent to the Station this year, with such facts as could be obtained regarding their cost, etc. The formulas by which the fertilizers were mixed are first given, followed by the table of analyses and valuations with some explanations and further remarks regarding them.

2455. Mixture for General Use. Made by the late J. J. Webb, Hamden.

FORMULA.

834	pounds	Dissolved Bone Black, costing		$10.43
666	"	Tankage,	"	9.32
208	"	Sulphate of Ammonia,	"	7.80
292	"	Muriate of Potash,	"	5.84
2000	"		"	$33.39
		Add freight to New Haven		1.60
		Total cost of raw material per ton		$34.99

Mr. Webb bought the above chemicals on guarantee, intending to have a mixture containing Nitrogen 4.75 per cent., Phosphoric Acid 8 per cent. and Potash 7.75 per cent. The analysis given further on will show how closely the calculation agreed with the actual composition.

2456. Mixture for Corn. Made by Dennis Fenn, Milford.

FORMULA.

700	pounds of	Ground Bone,	costing	$10.50
500	" "	Tankage,	"	7.15
1000	" "	Dissolved Bone Black,	"	13.00
300	" "	Sulphate of Ammonia,	"	11.19
250	" "	Muriate of Potash,	"	5.20
200	" "	Double Sulphate of Potash and Magnesia,	"	3.06
2950	"		"	$50.10

Cost of materials $50.10, or $34.00 per ton delivered at Milford.

2457. Mixture No. 1 and **2458,** Mixture No. 2. Made by C. T. Merwin & Son, Milford.

FORMULAS.

	Mixture No. 1.			Mixture No. 2.		
Sulphate of Ammonia,	166 lbs.,	costing	$6.19	133 lbs.,	costing	$4.99
Tankage,	666 "	"	9.52	530 "	"	7.58
Bone,	--- "	"	---	400 "	"	6.02
Dissolved Bone Black,	834 "	"	10.84	670 "	"	8.71
Muriate of Potash,	334 "	"	6.95	267 "	"	5.55
	2000 "	"	$33.50	2000 "	"	$32.85

Cost of materials $33.50 and $32.85 respectively, delivered at Milford.

2474. Mixture made by Edward Davis of Whitneyville.

FORMULA.

Home made Superphosphate	350 pounds.
Fish Scrap	350 "
Sulphate of Ammonia	110 "
Muriate of Potash	150 "
	960

The Superphosphate was made by dissolving in oil of vitriol refuse bone char from a factory where bone was used for case-hardening. The cost of material is unknown.

2588. Mixture for General Use. Made by N. D. Platt, Milford.

FORMULA.

500	pounds	Sulphate of Ammonia,	costing	$18.65
2000	"	Tankage,	"	28.60
500	"	Bone,	"	7.53
2000	"	Dissolved Bone Black,	"	26.00
500	"	Muriate of Potash,	"	10.40
270	"	High grade Sulphate of Potash,	"	8.26
5770	"	Total		$99.44

Cost of materials delivered at Milford $34.50 per ton.

2589. Mixture made by N. S. Platt, Cheshire.

FORMULA.

100	pounds	Bone,	costing	$1.75
300	"	Blood, Bone and Meat,	"	5.25
800	"	Dissolved Bone Black,	"	10.40
300	"	Double Sulphate of Potash and Magnesia,	"	4.50
1500	"	Total,	"	$21.80

Cost of the materials in New Haven ..... $29.07 per ton
Add freight 1.20

Cost of materials delivered at Cheshire $30.27

2591. Mixture made by R. M. Treat, Woodmont.

FORMULA.

900	pounds	Tankage,	costing	$12.87
340	"	Sulphate of Ammonia,	"	12.08
200	"	Ground Bone,	"	3.01
2000	"	Dissolved Bone Black,	"	26.00
560	"	Muriate of Potash,	"	11.65
4000	"		"	$66.21

Cost of materials delivered at Woodmont $33.11 per ton.

2592. Mixture for Corn. Made by Geo. F. Platt, Milford.

FORMULA.

450	pounds	Tankage,	costing	$6.44
450	"	Ground Bone,	"	6.77
232	"	Sulphate of Ammonia,	"	8.65
384	"	Dissolved Bone Black,	"	4.99
305	"	Muriate of Potash,	"	6.34
179	"	High-grade Sulphate of Potash,	"	5.48
2000	"		"	$38.67

Cost of materials delivered at Milford $38.67 per ton.

2593. Mixture for Potatoes. Made by G. F. Platt, Milford.

FORMULA.

500	pounds	Sulphate of Ammonia,	costing	$18.65
2500	"	Tankage,	"	35.75
2500	"	Ground Bone,	"	37.63
2500	"	Dissolved Bone Black,	"	32.50
750	"	Muriate of Potash,	"	15.60
550	"	Sulphate of Potash,	"	16.83
9300	"			$156.96

Cost of materials delivered at Milford $33.75 per ton.

2594. Mixture for Potatoes. Made by Dennis Fenn, Milford.

FORMULA.

200	lbs.	Sulphate of Ammonia,	costing	$7.46
500	"	Tankage,	"	7.15
650	"	Bone,	"	9.78
1000	"	Dissolved Bone Black,	"	13.00
250	"	Muriate of Potash,	"	5.20
800	"	Double Sulphate of Potash and Magnesia,	"	12.24
3400				$54.83

Cost of materials delivered at Milford, $32.26 per ton.

The raw materials used for these mixtures were for the most part purchased from L. Sanderson, of New Haven and C. Meyer, Jr., of Maspeth, L. I., and were sampled by station agents and analyzed early in the season. Knowing their composition and the quantity of each which was used, the composition of the mixtures can be calculated, assuming that all weights were correctly taken, that the materials had not lost or gained moisture and that both mixing and sampling had been thorough. These calculated analyses are given in the table to compare with the actual composition of the mixtures. The agreement is quite satisfactory, with the single exception of No. **2589.**

The mechanical condition of these mixtures is excellent and their chemical composition corresponds with that of the ready mixed "special fertilizers" and ammoniated superphosphates of the highest grade.

The cost above given is in every case based on the regular cash ton prices of the trade. The *actual* cost in many, if not all, of these cases has been considerably reduced by special club rates which are given where a number of farmers give a cash order through an agent for a car lot or more.

The average cost of materials in these home-mixed fertilizers has been $33.79 per ton delivered at the purchaser's freight station. Two dollars will fully cover the cost of screening and mixing. [From a dollar to a dollar and a half is the estimate of those who have done the work.] *At the highest estimate*, therefore, the average cost of these home-mixed fertilizers has been $35.79 per ton. The average valuation has been $38.65 per ton. In no case has the valuation been less than the cost of the chemicals mixed. The valuation of ready-mixed fertilizers on the other hand is quite uniformly less than their cost.

The advantages claimed for home-mixing are:

1. Each ingredient can be separately examined by the purchaser and if necessary sent to the Experiment Station for analysis. The detection of inferior forms of nitrogen or phosphoric acid is much easier and more certain in a single article than in a mixture.

2. It is self-evident that an intelligent farmer by home-mixing is better able than any one else can be to adapt the composition of his fertilizers to the special requirements of his land as well as of his crop, and how greatly the soil-requirements vary in this State,

Home-Made Fertilizers. Analyses and Valuations.

Station No.	Name.	Nitrogen.				Phosphoric Acid.					Potash.				
		As Ammonia.	Organic.	Total. Found.	Total. Calculated.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Calculated.	Found.	Calculated.	Chlorine.	Valuation per ton.	Cost of Chemicals (unmixed.)
2455	Estate of J. J. Webb, Mixture	2.50	2.44	4.94	*4.97*	5.73	2.38	.69	8.80	*8.69*	7.89	*7.56*	....	39.02	34.99
2456	Dennis Fenn, Corn Mixture	2.11	1.86	3.97	*4.28*	4.46	5.56	2.46	12.48	*12.22*	6.54	*6.16*	4.61	38.06	34.00
2457	C. T. Merwin & Son, Mixture No. 1	1.96	2.52	4.48	*4.50*	6.14	2.02	.64	8.80	*8.70*	9.35	*8.60*	....	38.68	33.50
2458	" " " No. 2	1.60	2.91	4.51	*4.24*	6.20	3.94	1.62	11.76	*11.51*	6.61	*6.90*	....	39.89	32.85
2474	Edward Davis, Mixture	2.89	1.61	4.50	....	3.43	2.15	2.28	7.86	....	8.98	....	7.74	34.80	....
2588	N. D. Platt, Mixture	2.04	2.65	4.69	*5.00*	4.44	4.03	1.07	9.54	*9.10*	8.05	*7.00*	4.80	39.35	34.50
2589	N. S. Platt, Mixture	....	1.83	1.83	*.95*	9.70	3.62	1.28	14.60	*14.92*	3.15	*5.56*	.17	32.38	30.27
2591	R. M. Treat, Mixture	1.95	1.95	3.90	*3.80*	7.48	3.10	.83	11.41	*11.20*	7.62	*7.30*	....	38.80	33.11
2592	George F. Platt, Corn Mixture	2.65	2.34	4.99	*5.02*	2.70	4.95	1.54	9.19	*9.29*	14.07	*12.56*	7.40	45.56	38.67
2593	George F. Platt, Potato Mixture	1.22	2.73	3.95	*4.24*	3.42	6.68	2.37	12.47	*11.83*	7.41	*7.27*	4.03	39.20	33.75
2594	Dennis Fenn, Potato Mixture	1.26	1.74	3.00	*3.09*	4.05	4.69	1.56	10.30	*10.27*	9.98	*9.93*	3.66	36.38	32.26

even over a small area, is strikingly shown by the field experiments annually reported by our farmers through the Stations.

3. It is claimed that the same quantity and quality of plant food costs much less in home-mixtures than in ready-made mixtures because the cash purchaser of fertilizer chemicals deals directly with the importer or manufacturer, not with the middleman or retailer, and receives quotations without reference to the prices asked in his neighborhood by retailers of the same goods.

There is no longer any question as to the expediency of home-mixing in many cases. From such raw materials as are in our markets, without the aid of milling machinery, mixtures can be and *are* annually made on the farm which are uniform in quality, fine and dry and equal in all respects to the best ready-made fertilizers.

The economy of home-mixing depends, of course, on the prices which sellers of mixed goods are willing to take and on the cost of fertilizer-chemicals delivered as near the farm as mixed goods can be bought.

There is always a chance for the farmer who studies the market and the needs of his farm to save enough in the purchase of the fertilizers to make just the difference between profit and loss on a crop, and in farming, as in everything else where competition is close, profit usually comes from care in these small margins of expense. Perhaps home-mixtures are not indeed always and everywhere cheaper or more economical than commercial mixtures, but it will often happen that money can be saved by the timely purchase of raw materials and their mixture on the farm. Each individual farmer ought to be the best or only judge of the economy of home-mixing in his particular case, as well as of the "formulas" which are best adapted to his soil and crops.

The attention of those who plan to try home-mixing is called to the following particulars:

1. Nitrogen has cost most this season in ammonia salts and castor pomace, from 18–18½ cents per pound; in nitrates it has cost from half a cent to a cent less. Cotton seed meal has been as in past years the cheapest source of quickly available nitrogen which in this material has cost from 12½ to 15 cents per pound.

2. At present the only superphosphate used in home-mixtures is dissolved bone black, but soluble phosphoric acid can be bought considerably cheaper in dissolved South Carolina rock. **See page 66.**

Besides superphosphates there are other sources of phosphoric acid which should be considered. On some soils Thomas-Slag has given as good results as superphosphates, and there are other native phosphates in which the ratio between cost and agricultural value may be for some soils and crops as favorable as in superphosphates. Fine

ground bone too, which contains from 24–30 per cent. of phosphoric acid and from 1.5–4.0 per cent. of nitrogen can be got for from $26–32 per ton; while bone black superphosphate, containing 17 per cent. of phosphoric acid and a small fraction of 1 per cent. of nitrogen costs $26.

3. Potash in sulphates costs about 6 cents per pound, in muriate from 4 to 4½ cents. Kainit contains large quantities of chlorine and should be regarded as an impure muriate rather than as a sulphate. Potash in kainit costs at retail more than in muriate, about 4.8 cents per pound. As may be seen on page 108 potash as carbonate and perhaps phosphate, has cost from 3.2 to 6 cents per pound in cotton hull ashes. At the lower figure they are an excellent source of potash. The only objection to their use is the great variation in quality. As a result of this the buyer can have no certainty regarding them without a chemical analysis.

Miscellaneous Fertilizers and Manures.

Cotton Hull Ashes.

2419. Dark colored. Sold by R. E. Pinney, Suffield. Sampled and sent by C. H. Wells, Suffield.

2493. Sold to Edward Austin of Suffield by Allen Wilson. Sampled and sent by Allen Wilson, Suffield.

2418. Light colored. Sold by R. E. Pinney, Suffield. Sampled and sent by C. H. Wells, Suffield.

2485. Sold by R. E. Pinney, Suffield. Sampled and sent by J. M. Brown, Poquonock.

2408. Sold by C. L. Spencer, Suffield. Sampled and sent by Edmund Halladay, Suffield.

2409. Sold by C. L. Spencer, Suffield. Sampled and sent by Edmund Halladay, Suffield.

2410. Sold by C. L. Spencer, Suffield. Sampled and sent by Edmund Halladay, Suffield.

2453. Sold by R. E. Pinney, Suffield. Sampled and sent by D. L. Brockett, Suffield.

2448. Sold by Wilder and Puffer, Springfield, Mass. Sampled and sent by B. R. Townsend, Wallingford.

2459. Sold by C. D. Cannon, Windsor Locks. Sampled and sent by I. C. Duran, Windsor Locks.

2429. Sold by R. E. Pinney, Suffield. Sampled and sent by Edmund Halladay, Suffield.

2454. Sold by R. E. Pinney to Wayne Rice, East Windsor Hill. Sampled and sent by R. E. Pinney.

Analyses of Cotton Hull Ashes.

Station Number.	2419	2493	2418	2485	2408	2409	2410	2453	2448	2459	2429	2454
Soluble phosphoric acid	2.78	2.40	1.28	2.30	.45	.48	.48	2.23	.75	.77	1.12	.03
Reverted phosphoric acid	6.44	8.07	5.77	5.67	7.80	7.93	8.06	5.98	6.43	7.05	5.46	2.20
Insoluble phosphoric acid	2.50	1.25	1.66	1.70	.34	.36	.36	2.02	1.81	.75	1.30	1.49
Potash	23.07	27.24	27.26	25.12	28.23	26.51	26.18	16.50	21.42	21.23	15.14	10.38
Cost per ton	$30.00	35.00	30.00	31.00	35.00	35 00	35.00	28.00	31.50	35.00	28.67	16.41
Valuation per ton	$42.79	49.14	44.08	43.01	46.43	44.62	44.42	33.15	37.27	37.32	28.67	16.41
Potash costs per pound in cents	3.2	3.4	3.4	3.6	3.9	4.2	4.2	4.4	4.6	5.4	6	6

The three samples from stock of C. L. Spencer, **2408, 2409** and **2410,** were drawn from different car loads. We understand that on learning that the lots represented by samples **2429** and **2454** were inferior, Mr. Pinney returned to the purchasers the money difference between cost and valuation. The per cent. of potash in these 12 samples varies from 28.23 to 10.38. This wide difference is largely due to carelessness, if nothing worse, at the mills where coal as well as hulls has to be used as fuel and the ashes of the two fuels are allowed to mix. Such carelessness if persisted in will soon destroy the market for these ashes.

Unleached Wood Ashes.

Large quantities of unleached wood ashes are now brought into Connecticut yearly from Canada and the northwestern states and are sold for from $11 to $15 per ton, in car lots.

The following analyses have been made of ashes brought into the State this year:

2537. Canada Ashes. Bought by N. S. Platt, Cheshire, from James Hartness, Detroit, Mich. Cost, 23 cents per bushel.

2587. Sampled and sent by F. A. Griswold, Wethersfield. Bought in Hartford.

2620. Screened Ashes. Bought by C. S. Gillette, Cheshire, from W. E. Fyfe & Co., Clinton, Mass. Cost, $11.00 per ton, in car lots at Cheshire.

2624. Canada Ashes, sampled and sent by G. L. Dunham, Southington, from stock of Burritt Hills, Plainville. Cost, $11.00 per ton. One bushel weighs 57½ pounds.

2628. Canada Ashes. Sold by Munroe, Judson & Stroup, Oswego, N. Y., to Atwood & Wilson, Watertown. Sampled and sent by D. B. Thompson, Watertown. Cost, $15.00 per ton.

2632. Sold by Forest City Wood Ash Co., London, Ont., Canada, to F. N. Bradley, Derby. Cost, $13.00 per ton.

Analyses.

	2537	2587	2620	2624	2628	2632
Potash, soluble in water..	4.48	4.01	3.77	4 91	5.33	6.04
Phosphoric acid.....	1.77	1.05	1.70	1.77	1.19	1.32
Lime.....			31.55	25.90	44.54	39.02
Carbonic acid.....			18.26	18.30	26.46	19.60
Sand and insoluble matters			16.25	25.65	8.45	12.38

The sample **2628** is fine and nearly white. The question was asked whether it was not mixed with lime. Such is perhaps the case, the high per cent. of lime being offset by the low percentage of sand and insoluble matters.

Ashes vary a good deal in composition, and some of the samples received this year are notably deficient in potash.

The following data show the average quality of ashes. 91 samples of unleached wood ashes, analyzed by Dr. Goessmann, of Massachusetts, between the years 1868 and 1889 (Rep. Mass. Ex. St., 1888, 202, and Bull. 33), had the following average composition :

	Average.	Maximum.	Minimum.
Potash	5.5	10.2	2.5
Phosphoric acid	1.9	4.0	.3
Lime	34.3	50.9	18.0
Magnesia	3.5	7.5	2.3
Insoluble matter	12.9	27.9	2.1
Moisture	12.0	28.6	.7

16 analyses made at the Connecticut Station between 1877 and 1889 had the following average composition :

	Average.	Maximum.	Minimum.
Potash	5.3	7.7	4.0
Phosphoric acid	1.4	1.8	1.0

The ashes from household fires in New England appear to be richer both in phosphoric acid and potash. 15 analyses, 13 of which were made by Prof. Storer, of the Bussey Institution, show the following average composition :

Potash	9.63
Phosphoric acid	2.32

The quality as well as the quantity of ashes from a given weight of wood depends very much on the kind of wood as well as on its freedom from dirt, etc.

A valuable series of analyses recently made at the Georgia Experiment Station illustrates this. According to the analyses, 10,000 pounds of several different varieties of wood, [exclusive of bark and having a uniform water content], contained the following quantities of the ingredients named. The samples were selected from trees growing as nearly as possible under like conditions and of medium age. [See table of analyses on page 112.]

The facts that these analyses are of the wood only, bark being removed, that the bark contains much less of these ingredients

than the wood, and that these ashes were pure—free from all sand or earth as well as carbonic acid—will explain why the percentages are so much higher than are found in analyses of ashes in market.

Leached and unleached Canada ashes have approximately the following percentage composition :

	Unleached Ashes.	Leached Ashes.
Sand, earth and charcoal	13.0	13.0
Moisture	12.0	30.0
Carbonate with some hydrate of lime	61.0	51.0
Potash [chiefly as carbonate]	5.5	1.1
Phosphoric acid	1.9	1.4
Other matters by difference	6.6	3.5
	100.0	100.0

It appears from this statement that more than half the weight of both leached and unleached ashes consists of lime, partly as hydrate but chiefly as carbonate ; the same material chemically as chalk or limestone but finer and so likely to be quicker in its action.

It has long been known that chalk or limestone may benefit both very heavy and very light lands making the one looser in texture and less apt to puddle and the other closer and more compact. It does this in the one case by separating the particles of sticky clay and in the other by filling up the interspaces of a coarse soil. A writer on agriculture in the early part of the last century says of chalk, "it causes great fertility especially on such lands as are apt to lose the riches of dungs laid on them, and to forget in a little time that they have had any kind and indulgent benefactor. Here chalk is of excellent use to drive away such ingratitude, having a retentive quality to enclose and stay the salts."

It needs to be borne in mind that potash or soda lye binds a clay soil making it heavier, more tenacious and cloddy than before, and it may be that on this account a heavy application of *unleached* ashes to a clay soil would either not help it at all or even damage it, while on light soils unleached ashes would be more beneficial than leached ashes. This favorable action on light soils has made ashes popular in this State where our soil is for the most part light and sandy. They "keep the soil moist" as the saying is, that is by filling up the pores and compacting it, the soil water is made to rise more readily in it from the subsoil bringing plant food with it and preventing drought.

Ten Thousand Pounds of Wood contained Pounds of the Ingredients named:

	Dogwood. Cornus florida.	Sycamore. Platanus occidentalis.	Post Oak. Q. obtusiloba.	Ash. F. Americana.	Red Oak. Q. rubra.	Hickory. Carya tomentosa.	White Oak. Q. alba.	Magnolia. M. grandiflora.	Georgia Pine. P. palustris.	Yellow Pine. P. mitis.	Black Pine. Picea nigra.	Chestnut. Castanea vulgaris.	Old Field Pine. P. mitis.
Potash	19.02	18.06	16.85	14.94	13.95	13.80	10.60	7.13	5.01	4.54	3.02	2.90	.79
Phosphoric acid	5.72	9.55	6.96	1.15	5.98	5.83	2.49	3.19	1.24	.96	.92	1.09	.73
Lime	26.41	24.73	35.61	7.60	27.40	18.40	7.85	14.21	18.04	15.16	12.46	7.93	12.12
Magnesia	4.67	.49	5.28	.10	3.05	4.86	.90	2.94	2.03	.74	.10	.34	1.17
The Pure* Ashes of the Woods contained the following Per cents. of the Ingredients named.													
Potash	28.04	23.17	21.92	46.04	24.66	28.60	42.16	19.54	15.35	19.70	14.30	18.10	3.85
Phosphoric acid	8.51	12.23	9.00	3.58	10.55	11.97	9.48	8.75	3.82	4.18	4.33	6.76	4.11
Lime	38.93	31.62	46.39	23 57	48.26	37.94	29.85	38.94	55.24	65.53	58.98	49.18	67.73
Magnesia	6.80	.62	6.88	.60	5.38	10.04	3.43	8.05	6.25	3.20	.50	2.11	6.54

*Free from carbon and carbonic acid.

Besides this action of ashes which is in large part at least mechanical, they also tend to correct "sourness" of the soil. In most cases this is not due to free acid but to the presence of soluble iron salts which in undue quantity are poisonous to plants and in smaller quantity show that the soil is stagnant, and needs aeration. Ashes precipitate these salts and open the soil that contains them to the air, by making it looser in texture.

When potash salts have been used in large quantities and the potash has been largely taken up by a rapidly growing crop as tobacco, leaving most of the acid with which the potash was combined in the soil, ashes or lime may profitably be used to neutralize it. Our best tobacco growers use stone lime or cotton hull ashes largely on their tobacco land with excellent results.

A third way in which ashes benefit land is in promoting nitrification; that process by which the more or less inert nitrogenous matters in the soil, are made to yield nitrates from which our field crops obtain most if not all their nitrogen supply. This process is in some way connected with the life of low organisms, which are invariably present in fertile soils. Nitric acid can only be produced however when carbonate of lime is present to supply a base with which the acid may combine, and a soil mildly alkaline is the one most favorable to the growth of these organisms and the formation of nitrates.

Such is, in brief, our present knowledge regarding the action of ashes. It is clear that the quantities of potash and phosphoric acid present do not wholly measure the value of ashes nor does it pay to buy them simply to supply a deficiency of these two things in the manure. The quantities of potash and phosphoric acid in a ton of ashes costing $12 to $15, can be bought in the form of muriate of potash and superphosphate of lime for $8 or $9. But ashes temper certain soils making them easier to work, moister, and more retentive of manure, correcting "sourness," promoting the solution of plant food in them and so preparing the way for the use of fertilizers which directly applied might be wasted. To accomplish these ends ashes have to be used in considerable quantity and probably a single heavy dose would help more than the same quantity applied in fractions through three or four successive years if the object is to change the mechanical condition of the soil strikingly.

Ashes of Birch Twigs.

2407. Ashes from a factory where oil of birch is distilled from birch brush, which is afterwards burned in the boiler furnace. None of the branches are more than two inches in diameter at the butt.

	2407
Potash	4.86
Phosphoric acid	5.89
Sand and soil	10.84

Ashes from Boiler Flues.

A sample of ashes from boiler flues, **2460,** contained .25 per cent. of potash and 1.00 per cent of phosphoric acid.

Tobacco Stems.

2402. Kentucky Stems, sent by Robert Aitken in November, 1888, Shaker Station. Cost $10.00 per ton delivered at Shaker Station.

2403. Connecticut Stems, sent by Robert Aitken. Cost $9.50 per ton.

Analyses.

	2402	2403
Water	26.70	13.47
Organic and Volatile matters	60.18	70.85
Mineral matter	13.12	15.68
	100.00	100.00
In the organic matters is Nitrogen	1.84	1.93
In the mineral matter are,		
Potash	8.03	6.41
Phosphoric acid	.67	.53
Sand	.64	.70

The Kentucky Stems, although they contain twice as much water as the Connecticut Stems, have considerably more potash. Valuing nitrogen, phosphoric acid and potash at 17½, 7 and 4¼ cents per pound respectively, the valuation of the Kentucky Stems is $14.20 and of the Connecticut Stems $12.95 per ton.

Wool Waste.

2590. Received from P. M. Augur, Middlefield. It appeared to be made up mostly of "tag-locks," unwashed wool containing considerable sheep dung.

Analysis.

Nitrogen	2.87
Phosphoric acid	.81
Potash	5.38

With nitrogen reckoned worth 8 cents, phosphoric acid 7 cents and potash 4½ cents per pound, the total valuation will be $10.57 per ton. This slowly decomposing fertilizer is especially suitable for fruit trees and grape vines or grass, where an enduring rather than quick effect is desirable.

Damaged Corn Meal.

2496. Sample of a car-load, 56,000 pounds, which was offered to parties in Suffield for $50.00. It contained 1.32 per cent. of nitrogen, about .60 per cent. of phosphoric acid and .40 per cent. of potash. In one ton of the meal, costing $1.80, there are therefore :

26.4	pounds of	nitrogen at 15 cents, worth	$3.96
12.0	"	phosphoric acid at 7 cents, worth	.84
8.0	"	potash at 4½ cents, worth	.36
Ton-valuation			$5.16

The margin of $3.36 (valuation less cost) is not large enough to warrant transportation to any great distance.

This meal has about twice as much nitrogen as good stable or yard manure, and this nitrogen is doubtless at least twice as available or effective as that of stable manure ; it also contains nearly the same proportions of phosphoric acid and potash as stable manure. Heavy applications would for a time greatly improve the texture and water-holding capacity of light sandy soils.

Muck.

2619. Muck from Quinnipiac brick yards. Sampled and sent by T. A. Stanley, New Britain.

ANALYSIS.

Water	67.60
Organic and volatile matter	23.05
Ash	9.35
	100.00
The organic matter contains nitrogen	.46
The ash contains, phosphoric acid	.06
potash	.02
sand and soil	7.10

The *dry* muck contains:

Organic and volatile matter	71.13
Ash	28.87
	100.00
Nitrogen	1.43
Phosphoric acid	.20
Potash	.06

MUSSELS.

2413. A sample of fresh mussels. Sent by W. R. Hopson of Bridgeport, contained :

Water	50.75
Nitrogen	.56
Phosphoric acid	.10
Potash	.08

PLASTER.

2465. Sold by L. Sanderson, New Haven. Sampled and sent by W. H. Hammond, Elliott.

ANALYSIS.

Hydrated sulphate of lime (gypsum)	77.62
Matters insoluble in acid	7.08
Other matters, chiefly carbonate of lime	15.30
	100.00

STABLE MANURE.

Two samples of manure have been received from F. H. Stadtmueller, manager of Vine Hill Farm, West Hartford, who sent the following description :—

"We send you two samples of manure such as is being applied to the land with which we desire to attempt the maintenance of a debit and credit account relative to the amount of plant food supplied and removed. The sample contained in the box marked

Analyses of Manure.

	A	B		Mixed Man're. Young Cattle and Horses.	C	D	E	F	G	H	I	J
	Cow Man're. Winter feed.	Cow Man're. No litter.	Cow Manure 2491	2490	Fresh dung of Steers. No litter.	Horse Manure from N. Y.	Horse Man're, Ithaca, N. Y.	Horse Man're, N. Y. City.	Fresh dung of Horse.	Old Mixed Farm Manure	Mixed Farm Manure	Mixed Farm Manure
Water	76.19	85.30	71.69	77.08	82.30	75.76	70.79	69.30	67.28	54.70	79.95	75.57
Organic and Volatile matter	20.72	12.66	18.23	15.50	15.53	19.17		25.65	26.23	10.87		
Ash	3.09	2.04	10.08	7.42	2.17	5.07		5.05	6.49	34.43		
	100.00	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00		
Potash	0.60	.36	.48	.71	.27	.51	.53	.63	.22	.16	.84	.70
Soda		.04	.10	.09		.09						
Lime	0.58	.29	.17	.34	.77	.30		.74	.17	.47		
Magnesia	0.03	.19	.13	.15	.15	.19		.29	.20	.50		
Oxide of Iron and alumina		.09	.84	.63	.14	.19						
Sulphuric Acid		.04	.09	.12	.16	.09						
Phosphoric Acid	0.52	.16	.30	.34	.14	.41	.21	.67	.35	.72	.40	.29
Chlorine		.07	.06	.11	.21	.07						
Sand, clay and insoluble matters		.80	7.91	4.93	.33	3.22						
Nitrogen as												
Ammonia		.26	.13	.16	--	.26		.12	.15	.01		
Organic		.27	.30	.37	--	.27		.57	.32	.45		
Total	0.79	.53	.43	.53	.20	.53	.51	.69	.47	.46	.78	.68

1, (2490) was taken from a heap which was made from the accumulations of a barn containing only young growing animals and a few horses. Liberal quantities of bran, a few oats and a little corn meal, with good herds grass made up their feed. The other sample, marked 2, (2491) is manure made by milch cows whose feed was corn meal, bran, herds grass, hay and roots, all fed in liberal quantities. Most of the animals in the barn where this manure was made have attained their growth, have changed but little in flesh, have given a fair amount of milk and are in all stages of gestation."

The analyses of these two samples are given in the following table, and with them such other American analyses of horse manure, manure of cows and steers and mixed yard manure, as we have been able to find for comparison.

A, is Cow Manure, winter feed. Analysis made at the Bussey Institution.

B, is Cow Manure. No litter. Feed, hay as much as the cows will eat, 4 quarts wheat bran and 4 quarts mangolds. Analysis by Prof. S. W. Johnson in 1874.

C, Dung, no urine, of steers, fed 24 pounds of alfalfa per day. No litter. Analysis made at Colorado Agricultural Station.

D, Horse Manure from stables in New York city. Analysis by Prof. S. W. Johnson in 1874.

E, Horse Manure from Cornell University Agricultural Station. Horses fed liberally on oats and hay. The manure contained 30 pounds of straw bedding and 466 pounds of mixed dung and urine.

F, another sample of New York stable manure. Analysed at this Station in 1880.

G, Fresh Horse Dung from a horse fed daily with 14 pounds of timothy hay and 4 quarts of oats mixed with cracked corn. Somewhat dried. Analysis made at the Bussey Institution.

H, Old Yard Manure, made by young cattle fed in yard on hay. It represents well-rotted yard manure in its usual washed condition. Analysis made by Prof. S. W. Johnson in 1874.

I, Mixed Cow and Horse Manure from a bed two feet thick, packed solid by the treading of cattle. It was estimated that 80 tons of straw had been used as bedding and that 466 tons of manure were produced. Analysis made at Cornell University.

J, Similar to I, produced in another year when less cotton seed meal was used. Analysis made at Cornell University.

These analyses serve to give a general idea of the variations in Stable Manure. The two things which are subject to greatest variation are of course moisture and sand, clay, etc. The feed has a great effect on the quality of the manure. In its passage through the animal the food loses what is taken out by the growth of the animal and by the milk. A good deal of carbonaceous matter, which has no fertilizing value, is also burned in the system to supply animal heat, but all the rest of the food passes (undigested) into the dung or (digested) into the urine. Other things being equal, the richer the food is, the richer will be the manure.

The manure of milk cows is generally regarded as less valuable than that of other stock. This is explained by the large quantity of fertilizing material withdrawn by the milk and by the calf which is annually dropped.

According to a calculation which is made in the Report of the New Hampshire Agricultural Station for 1888, page 90, 4,000 pounds, 1,356 quarts of milk, which is assumed as the average yearly yield of a Durham cow, carry 19.2 pounds of nitrogen, 7.6 pounds of phosphoric acid and 8.3 pounds of potash. 2,600 pounds of yard manure like samples I and J contain the same quantity of nitrogen, 2,100 pounds of manure contain the same quantity of phosphoric acid, while 1,100 pounds of manure contain as much potash.

On the whole it is fair to say, that the milk of a cow carries off from the farm, in the course of a year as much plant food as a ton of ordinary stable manure.

While we have no accurate data as to the food consumed by the cows and the growing cattle that produced the two samples of manure sent by Mr. Stadtmueller, described above, we may fairly assume that the food of the cows was as concentrated as that of the growing cattle. If so, a comparison of the composition of the manure will show something of the loss due to the flow of milk and to the calf. For this comparison water, and the sand and soil are dropped from the calculation not being part of the food and subject to large accidental variation. Most of the iron and alumina was doubtless derived from the soil, but they are not reckoned out as their presence does not interfere with the comparison.

	2491 Dry Cow Manure; free from sand.	2490 Dry Manure of young cattle; free from sand.
Organic and volatile matter	89.33	86.02
Ash	10.67	13.98
	100.00	100.00
Potash	2.35	4.00
Soda	.49	.50
Lime	.83	1.83
Magnesia	.64	.84
Oxide of iron and alumina	4.16	3.56
Sulphuric acid	.44	.69
Phosphoric acid	1.47	1.92
Chlorine	.79	.64
	10.67	13.98
Total nitrogen	2.10	2.94

This comparison shows the striking deficiency of potash, lime, phosphoric acid and nitrogen in the manure of cows, due largely no doubt to the causes before mentioned.

Hall's Coral Fertilizer.

Described by the makers as follows:

"This Fertilizer ranks with the best in the world. It is more necessary to the soil than Phosphates or bone."

"It will destroy potato bugs and is sure death to all worms and insects."

"Sold by all first class dealers every where at $15.00 per ton."

Manufactured by the Vermont Chemical Fertilizer Co, Vergennes, Vt.

No. **2646.** A sample package of the above material, received from D. H. Van Hoosear, Wilton, had the following composition:

	2646
Carbonate of lime [ground limestone]	94.77
Matters insoluble in acid	3.54
Other matters by difference	1.69
	100.00

It contained only traces of nitrogen and phosphoric acid.

No further comment is necessary on the absurd claims of the manufacturer.

REVIEW OF THE FERTILIZER MARKET.

For the Thirteen Months ending Dec. 31, 1889.

Nitrogen.

Nitric Nitrogen.

The average *wholesale* quotation of nitrogen in nitrate of soda in New York was 14.6 cents per pound in November of last year. In December it rose to 15.2 cents. In April, 1889, it was quoted at 14.6; in May at 13.8, and it continued to decline to 11.9 cents in August. This is the lowest figure for the year. Since then it has risen to 12.4 cents per pound.

It has *retailed* in Connecticut during the year for about 17½ cents a pound.

Ammonic Nitrogen.

The average *wholesale* quotation of nitrogen in sulphate of ammonia in New York during the last two months of 1888 and the first three months of 1889 was 16.6 cents per pound. In April it was 16.2, in May 15.7 and in August, September and October 15.0. For the last two months it has been quoted at 15.4 cents per pound.

It has been *retailed* in Connecticut during the year for from 18 to 18½ cents per pound.

Organic Nitrogen.

The nitrogen of high-grade red blood was quoted at wholesale in New York during November and December, 1888, at about 16.2 cents per pound. It rose then to 16.6 in March, 1889, then fell off steadily; in May was quoted at 15.2, in July 14.8, in Oct. 13.8, and in Dec. at 12.7 cents per pound.

The wholesale quotations of nitrogen in low-grade black blood have been quite uniformly from .3 to .5 of a cent per pound lower than in red blood for the same month.

The wholesale quotations of nitrogen in Azotin have also followed the same fluctuations as in red blood and generally have been a fraction of a cent per pound higher.

The wholesale quotation of dried fish-scrap, which is considerably used as a source of nitrogen in mixed fertilizers, was $23.75 per ton in July, August and September. It has been quoted during the later months of the year for $21.00.

As has been shown in preceding pages, organic nitrogen has *retailed* in Connecticut the past season at about 20 cents per pound in dried blood, from 18 to 19 cents in castor pomace, and from 12.2 to 14.9 cents per pound in cotton seed meal.

Phosphatic Materials.

Refuse Bone Black which was quoted at wholesale in New York early in the year at about $19.50 has been quoted at $20.25 since July.

Rough and Ground Bone have risen from $19.00 and $24.00 per ton respectively in Nov. 1888, to $21.50 and $26.50, at which prices they are still quoted.

Ground Charleston Rock, f. o. b., N. Y., quoted early in the year at $10.25 has been quoted since May at $11.25.

Oil of Vitriol 66° B, was quoted at 1.10 cents per pound till July and has risen since then to 1.37½ cents.

Acid Phosphate, 14 per cent. available, was quoted in January at 86 cents per unit at wholesale. It fell in May to 81¼ cents and has remained at that figure ever since. This is equivalent to 4.06 cents per pound for available phosphoric acid.

Potash.

Muriate of Potash.

The *wholesale* New York market quotations of potash in the form of muriate have been very uniform and have varied month by month not more than two-tenths of a cent per pound, and closed in Dec. at 3.64 cents per pound.

It has *retailed* in Connecticut from 4 to 4.6 cents per pound.

Double Sulphate of Potash and Magnesia.

Potash in this article has been quoted at *wholesale* in New York from 4.44 to 4.63 cents per pound, showing as little fluctuation as the muriate.

It has *retailed* in Connecticut from 5.4 cents to 5.9 cents per pound within the year.

High Grade Sulphate of Potash, 98 per cent.

Potash in this article was quoted at *wholesale* in New York at 5 cents in January, fell to 4.6 cents in July and closed in December again at 5 cents per pound.

The single *retail* quotation in Connecticut the past season has been 5.8 cents per pound for potash, $61.20 per ton for the sulphate.

Kainit.

This article has been quoted at *wholesale* in New York from $10.15 to $10.50 per ton, or about $10.40 on the average. If kainit contains 12.5 per cent. of actual potash this is equivalent to about 4 cents per pound at wholesale for potash.

Potash has cost at *retail* in Connecticut from 4¾ to 5 cents per pound in Kainit.

In general, the wholesale price of nitrogen in ammonia salts has fallen slightly within the year, in nitrate of soda it has fallen very considerably and still more decidedly in organic forms such as blood and azotin: from 16½ to 12¾ or 13¼ cents per pound.

On the other hand there has been a rise of a dollar or more per ton in phosphatic materials, bone black, bone and South Carolina Rock and also a marked rise in 66° Oil of Vitriol.

The wholesale quotations of potash salts have remained practically unchanged from the beginning to the end of the year.

The market quotations given above are taken from the "Oil, Paint and Drug Reporter," published in New York. The weekly quotations for each month are averaged, and this average is taken as the quotation for the month.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review:

Phosphate rock, kainit, bone, fish-scrap, tankage, and some other articles are quoted and sold by the ton. The seller usually has an analysis of his stock and purchasers often control this by an analysis at the time of purchase.

Sulphate of ammonia, nitrate of soda and muriate of potash are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

Blood, azotin and ammonite are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the percentage of ammonia by 14 and divide that product by 17). A "unit of ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to

8.5 per cent. of ammonia, it is said to contain 8½ units of ammonia, and if quoted at $2.25 per unit, a ton of it will cost 8½ × 2.25 = $19.13.

The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given:

Ammonia at	$3.00	per unit	is equivalent to	nitrogen at	18.2	cts. per lb.
"	2.90	"	"	"	17.6	"
"	2.80	"	"	"	17.0	"
"	2.70	"	"	"	16.4	"
"	2.60	"	"	"	15.8	"
"	2.50	"	"	"	15.2	"
"	2.40	"	"	"	14.6	"
"	2.30	"	"	"	14.0	"
"	2.20	"	"	"	13.4	"
"	2.10	"	"	"	12.8	"
"	2.00	"	"	"	12.2	"
"	1.90	"	"	"	11.6	"
"	1 80	"	"	"	11.0	"

Commercial Sulphate of Ammonia contains on the average 20.5 per cent. of nitrogen, though it varies considerably in quality. With that per cent. of nitrogen (equivalent to 24.3 per cent. of ammonia),

At	4	cents per lb.	Nitrogen costs		19.5	cents per lb.
"	3⅞	"	"	"	18.9	"
"	3¾	"	"	"	18.3	"
"	3⅝	"	"	"	17.6	"
"	3½	"	"	"	17.0	"
"	3⅜	"	"	"	16.4	"
"	3¼	"	"	"	15.8	"
"	3⅛	"	"	"	15.2	"
"	3	"	"	"	14.6	"
"	2⅞	"	"	"	14.0	"
"	2¾	"	"	"	13.4	"

Commercial Nitrate of Soda averages 95 per cent. of the pure salt or 15.6 per cent. of nitrogen.

If quoted at	3	cents per lb.	Nitrogen costs		19.2	cents per lb.
"	2⅞	"	"	"	18.3	"
"	2¾	"	"	"	17.6	"
"	2⅝	"	"	"	16.9	"
"	2½	"	"	"	16.0	"
"	2⅜	"	"	"	15.2	"
"	2¼	"	"	"	14.4	"
"	2⅛	"	"	"	13.6	"
"	2	"	"	"	12.8	"
"	1⅞	"	"	"	12.0	"
"	1¾	"	"	"	11.2	"

Commercial Muriate of Potash and also High Grade, 98 per cent., Sulphate of Potash usually contain 50½ per cent. of actual potash.

If quoted at	2.60	cents per lb.	Actual Potash costs		5.15	cents per lb.
"	2.50	"	"	"	4.95	"
"	2.40	"	"	"	4.75	"
"	2.30	"	"	"	4.55	"
"	2.25	"	"	"	4.45	"
"	2.20	"	"	"	4.35	"
"	2.15	"	"	"	4.25	"
"	2.10	"	"	"	4.15	"
"	2.05	"	"	"	4.06	"
"	2.00	"	"	"	3.96	"
"	1.95	"	"	"	3.86	"
"	1.90	"	"	"	3.76	"
"	1 85	"	"	"	3.66	"
"	1.80	"	"	"	3.56	"
"	1.75	"	"	"	3.46	"
"	1.70	"	"	"	3.36	"

The Double Sulphate of Potash and Magnesia has about 26½ per cent. of actual potash.

If quoted at	1.00	cent per lb.	Actual Potash costs		3.77	cents per lb.
"	1.05	"	"	"	3.96	"
"	1.10	"	"	"	4.15	"
"	1.15	"	"	"	4.34	"
"	1.20	"	"	"	4.53	"

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since April, 1885. The price given for each month is the average of the four weekly quotations in that month. Sulphate of ammonia is assumed to contain 20.5 per cent. and nitrate of soda 15.6 per cent. nitrogen, and muriate of potash 50½ per cent. of actual potash or 80 per cent. of the pure salt.

Wholesale Prices of Fertilizing Materials.

		Cost of Nitrogen at wholesale in				Cost of Potash at wholesale in			
		Blood. Cents per pound.	Azotin or Ammonite. Cents per pound.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate of Potash. Cents per pound.	Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
1886.	July	14.2	14.4	14.9	14.6	3.31	---	---	---
	August	14.1	14.4	14.0	14.5	3.31	---	---	---
	September	14.1	14.4	13.7	14.4	3.40	---	---	---
	October	14.4	14.4	13.2	14.6	3.41	---	---	---
	November	14 0	14.4	12.7	14.7	3.41	---	---	---
	December	13.3	14.5	13.1	14.7	3.41	---	---	---
1887.	January	13.3	14.5	13.0	14.6	3.41	---	---	---
	February	13.5	14.5	13.6	14.6	3.41	---	---	---
	March	13.4	14.5	14.3	14.5	3.51	---	---	---
	April	13.6	14.1	14.9	14.5	3.56	---	---	---
	May	13.4	14.0	14.7	14.5	3.48	---	---	---
	June	13.1	14.0	14.0	14.5	3.41	---	---	---
	July	13.1	14.0	12.0	14.5	3.41	---	---	---
	August	12.6	13.4	11.8	14 5	3.40	---	---	---
	September	12.1	12.5	12.2	14.7	3.36	---	---	---
	October	12.1	12.3	13.0	14.9	3.36	---	---	---
	November	11.8	12.2	12.7	14.7	3.41	---	---	---
	December	12.1	12.3	13.8	14.9	3.46	4.08	---	---
1888.	January	12.2	12.3	13.8	14.9	3.48	4.24	---	---
	February	12.6	12.6	13.3	14.9	3.48	4.49	---	---
	March	13.9	13.6	13.1	14.9	3.46	4.15	---	---
	April	13.9	13.6	12 9	14.9	3.46	4.11	---	---
	May	13.9	13.6	12.8	15.2	3.52	4.24	---	---
	June	14.0	13.6	13.1	14.9	3.50	3.86	---	---
	July	14.2	13.9	13.1	14.9	3.50	3.86	---	---
	August	14.5	14:2	13.2	14.9	3.50	3.86	---	---
	September	14.6	14.2	13.9	15.3	3.71	4.38	---	---
	October	15 0	15.0	14.1	15.8	3.71	4.47	---	---
	November	15.9	16.2	14.6	16.4	3.72	4.48	---	3.89
	December	16.0	16 5	15.2	16.4	3.71	4.53	---	3.89
1889.	January	16.3	16.6	15.1	16.6	3.66	4.63	5.00	4.30
	February	16 5	17.0	15 0	16.6	3.66	4.44	5.01	4.37
	March	16.5	17 1	15 2	16.6	3.66	4.48	4.88	4.20
	April	16.0	16.1	14.6	16.2	3.57	4.44	4.85	4.10
	May	15 1	15.2	13.8	15.7	3.64	4.49	4.65	4.06
	June	14.9	14.6	12.8	15.2	3.64	4.53	4.60	4.06
	July	14.6	14.2	12.5	15.1	3.64	4.53	4.56	4.06
	August	14.6	14.2	11.9	15.0	3.64	4.53	4.56	4.06
	September	13.9	14.2	12.1	15.0	3.64	4.44	4.66	4.06
	October	13.6	13.7	12.2	15.0	3.64	4.44	4.67	4.06
	November	13.2	13 6	12.3	15.4	3.64	4.44	4.75	4.06
	December	12.6	13.3	12.4	15.4	3.64	4.44	4.98	4.06

REPORT OF ROLAND THAXTER, MYCOLOGIST.

Introductory Note.

In view of the fact that the subject of Fungi and Fungus Diseases has not previously received attention in these reports, a word or two by way of introduction to the subject, may not be out of place here.

Fungus or fungous disease, that is, a disease caused by a fungus or by fungi, is the term properly applied to a majority of the ailments among plants, which are commonly and loosely designated by such names as blast, blight, mildew, mould, rot, rust, scab, scald and smut, all of which convey to the mind a more or less confused and inaccurate idea of what they are intended to distinguish. Such diseases are accurately known only by the scientific names which have been given to the fungi which cause them. For example the onion smut in Connecticut is known as *Urocystis Cepulæ; Urocystis* being the generic or group name given to all smuts having the special characters found in the onion smut, while *Cepulæ*, which notes the fact that it is found on small cultivated onions, is the special name applied to the particular species mentioned. Some accurate means for popular designation of such diseases is much to be desired : yet owing to the difficulty which the ordinary observer must needs have in distinguishing them, it is not easy to imagine a popular nomenclature of any kind, which would be other than chaotic, based as it must be on a general ignorance of the thing designated.

Whatever different names we may decide to give to them, or rather to their visible effects or products, their nature is practically the same in all cases. That is the injury is caused by certain lowly organized plants, living on or in the tissues of the plant which harbors them and is conveniently called their *host*, or *host plant*. For our purpose it is sufficiently accurate to say that their vegetative portion consists of an indefinite growth of thread-like tubes, which usually branch in growing on or through the tissues of the host, and absorb from them their contained nutriment. Such thread-like tubes are called *hyphæ*, and from them are produced the reproductive bodies of the fungus, usually in the form of what are called *spores*. The spores, which correspond in many cases to the seeds of higher plants and perform the same function, are very various in their size, shape,

color and markings. Many are simple, composed of a single cell, as in fig. 33, while others are compound, divided by partitions into from two to sometimes very many cells, as in fig. 42. They are usually very minute and invisible to the naked eye except in the mass. In germination, which takes place under proper conditions of warmth and moisture, one or more hyphæ are produced from the spore or its divisions, and on or from the hyphæ thus produced, are ultimately formed more spores similar to that from which they sprang. In a general way then, and in the simplest case, the individual fungus plant may be said to consist of a spore, producing a series of threads on which are borne other spores similar to that to which they owed their origin.

Instead of producing one kind of fruit, however, like the majority of higher plants, the conditions of life are such among fungi that, in the majority of cases, a secure provision for their survival from year to year, as well as for their rapid reproduction during the growing season, demands the formation of at least two kinds of reproductive bodies, often more. One, at least, of these commonly serves as a resting stage, and is adapted to withstand unfavorable conditions, such as drought and cold, for considerable periods; while the rest are commonly short lived and are designed to spread the disease rapidly during favorable conditions. The resting stage is commonly a thick walled spore, like that of the onion *Urocystis;* but the same object of withstanding unfavorable conditions and perpetuating the fungus from year to year, is often effected through the hyphæ themselves, which may become compacted and hardened so as to retain their vitality for a considerable period and withstand very unfavorable conditions ; giving rise again to a growth of spore-producing hyphæ under favorable conditions. A familiar instance of this kind is seen in the ergot of rye, etc., which, with other similar formations, is called a *sclerotium.* Still another means by which fungi may be perpetuated from year to year through the hyphæ, consists in the simple survival of the latter within the living tissues of the host plant, a renewed growth and spore-production arising from them every season. Of such *perennial* forms the common raspberry rust is a well known instance.

All fungi are parasitic, that is, are dependent for their existence on the work of other organisms, being unable to elaborate their own food. Not all of them, however, grow upon living organisms, whether plants or animals; a very great number being par-

asitic on dead organic matter. Members of the last class, such as the common moulds on bread, etc., have been called *saprophytes:* while such fungi as are only known to complete their cycle of growth in or upon the tissues of living plants or animals are known as *true parasites.* Although no hard and fast line can be drawn between these two classes, owing to the fact that even saprophytes may occasionally assume a parasitic habit and *vice versa*, the distinction is sufficiently well marked, and it is with the class of true parasites that we have to deal in considering the subject of fungus diseases of crops.

ON CERTAIN FUNGUS DISEASES OF THE ONION (ALLIUM CEPA).

It is the purpose of the present account to call attention to some of the more important diseases of the onion due to the attack of parasitic fungi and prevalent in Connecticut during the past season. Particular attention has been given to the so-called "smut" of onions (*Urocystis Cepulæ*) with a view to discover some effective means of treatment or indicate the possibility of such treatment. It is with reluctance that a report of any kind upon this subject is presented after the observations of only a single season, since these results could hardly be expected to furnish more than data for a second season's work, owing to the fact that no systematic experiments for the prevention of such diseases ("smuts") other than through treatment of the seed, seem to have been previously attempted. The results obtained being, however, not wholly without practical value, are given for what they are worth; further investigation of the subject being left for another season.

The "Smut" of Onions, (*Urocystis Cepulæ* Frost.)

Plate II., figs. 1–2, and 17–28.

At a meeting of the Green's Farms Farmers' Club, held in the winter of 1887, pursuant to a motion of the club, the Experiment Station was requested to undertake an investigation of the Onion smut in view of the fact that, in various localities in the state, it has long been a destructive disease, for which no effective remedy has been found. In compliance with this request the Station has given attention to the matter during the past season, through this department, and the following is presented as a report of the preliminary investigation.

The season was in some respects an unfortunate one for such a purpose, following as it did the over-production of onions which characterized the season of 1888 and led farmers to look rather to a means of lessening than of increasing the crop. The failure of the Station in its effort to procure general information on the subject, from persons directly interested, may therefore be a natural consequence of the indifference resulting from this cause.

For the purpose of obtaining such general information, the following set of questions concerning the 'smut' was sent to persons known to be interested in onion culture :—

1. How long has the onion smut been known in your vicinity ?

2. Have you noticed that the prevalence of smut is influenced by

(*a*) the variety of onions grown.

(*b*) early or late planting.

(*c*) method of cultivation and nature of soil.

(*d*) condition of weather during germination and early growth of onions.

3. How long have you known the smut to remain in the ground after the cultivation of onions has been discontinued ?

4. Is this period affected by the crop grown on such land ? For example, is smut as bad on land which has been used for hoed crops as on land which has been put down to grass ?

5. Have you ever seen smut damaging sets or seed onions ?

6. Do wild onions grow commonly in your locality, and have you ever seen them smutted ?

7. What means have you used to prevent or lessen the amount of smut ?

8. About what per cent. of your crop is destroyed, on an average, by smut ?

9. What is your own idea as to the nature, origin and spread of smut ?

10. Can you give any general information on the subject not covered by the above questions ?

These questions were accompanied by the following note :

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.
NEW HAVEN, March 4, 1889.

Dear Sir : The enclosed questions are addressed to farmers interested in the cultivation of onions, for the purpose of procuring any information which may be of service in connection with experiments for the

prevention of the onion smut. You will therefore confer a favor by answering them (by numbers) as far as you are able, and returning them to the enclosed address. To render the answers of any value they must represent the results of *personal* observation or experience without reference to the observations of others.

An envelope stamped and addressed to the Station accompanied this letter, which was sent to one hundred and fifteen onion raisers, and elicited only twenty-six answers. An attempt to procure information as to the general distribution of the disease in the State, through the Masters of the local Granges was also unsuccessful, owing to the failure of about half of the persons addressed to return the postal card which accompanied the inquiry in every case. Personal observation, therefore, supplemented by the previous knowledge of the disease, for the most part forms the basis of the following account.

The writer desires to express his acknowledgments to those who kindly noticed the above requests and especially his obligation to Mr. S. M. Wells, of Wethersfield, and Messrs. A. C. and E. J. Taylor and Mr. S. M. Sherwood, of Greens Farms, for their kindness in aiding his observations.

History.—Although the disease known as onion smut (*Urocystis Cepulæ* Frost) has, according to apparently trustworthy information, been known in Connecticut since about the year 1860, the first notice of the fungus as causing a serious disease of onions, is, as far as can be discovered, that contained in the report of the Massachusetts State Board of Agriculture for 1869–70, in which (Appendix p. 10) Mr. B. P. Ware refers to its injuries in Massachusetts. It is also referred to as injurious in the Report of the U. S. Commissioner of Agriculture for 1869 and 1872, and in the last mentioned volume under the heading "Onion Blight and Smut (*Genus Peronospora*)" on p. 193, several spores of the smut are figured. Although associated with other unknown bodies and placed under a genus (*Peronospora*) with which they have no possible connection, the smut spores are quite recognizable as belonging to *Urocystis Cepulæ* and are the earliest published figures of the fungus.

The next reference to the onion smut is found in an essay on the subject by Prof. W. G. Farlow, contained in the Annual Report of the Massachusetts Board of Agriculture for 1876–77, in the "Abstract of Returns of the Agricultural Societies of Massachusetts" (p. 164, with plate) a paper which forms the

only basis of accurate knowledge on the subject which we possess. In this article Prof. Farlow describes the fungus which causes the disease for the first time as *Urocystis Cepulæ* Frost, this being a manuscript name appended to specimens sent to him by Mr. C. C. Frost of Brattleborough, Vermont. The history and character of the fungus are also described, so far as they were then known, and a general account given, with suggestions as to measures which would be likely to check the disease.

Up to this time the disease was considered to be peculiar to America, as is stated by Prof. Farlow in the paper referred to, but the same author in the Bulletin of the Bussey Institution, Vol. ii, p. 114, (1877) appears to consider it identical with a form found in Italy on a species of wild onion (*Allium magicum*) by Prof. Passerini and described and distributed by him in Thuemen's Mycotheca Universalis, No. 223, under the name *Urocystis magica* Pass. A further note on the subject by Prof. Farlow occurs in the Bussey bulletin, Vol. ii, p. 238.

In the same year (1877) M. C. Cooke in the Gardiner's Chronicle, p. 634, refers to the American onion smut as only a varietal form of a species (*Urocystis Colchici* (Schlecht.)) found in Europe on *Colchicum* and allied plants, but unknown in America; and calls our species "*Urocystis Colchici* variety *Cepulæ*."

In 1879, Maxime Cornu (in Comptes Rendus de l'Academie des Sciences, Vol. lxxxix, p. 51, Paris, 1879, and in the Bulletin de la Société Botanique de France, Vol. xxvi, p. 263, Paris 1879) records the appearance of the true American onion smut (*Urocystis Cepulæ*) in the neighborhood of Paris, and considers it as recently introduced from the United States. It may be observed that, previous to this, a smut was observed on the common onion (*Allium cepa*) from southern France in the herbarium of the university of Strassburg, by J. Schroeter, which is referred to as *Urocystis Colchici* in his article entitled "Remarks and Observations on certain Ustilagineæ" (smuts) in Cohn's Beiträge zur Biologie der Pflanzen, Vol. ii, p. 349, (1877), and may perhaps have been our species. A notice of the occurrence of the true onion smut in France at Rouen, is also recorded by Malbranche in the Bull. d. l. Soc. Bot. de France, 2d Series, Vol. iii, p. 277 (1881): while in the same journal, Vol. xxvii (1880), p. 39), Prof. Cornu gives certain observations on the onion smut (*Urocystis Cepulæ*), and states that he had inoculated seedlings with it and that they had died "probably" from this

cause, also suggesting that the comparative unimportance of the disease in France, as compared with America, is due to the fact that the french gardeners transplant their onion seedlings when small, selecting only healthy plants.

In the same year (1880) E. Hallier (according to Just, 1881, I, p. 261) in the Wiener Illustrirter Gartenzeitung, Vol. v, p. 519, in an article on "Der Brandpilz der Kuchenzwiebel, *Urocystis Cepæ*," calls attention to the fact that in the same journal (Nos. 7–9) in 1878, he had described and figured the fungus which had been very common in his garden in 1877. Whether this author in the paper cited describes the fungus as a new species (*U. Cepæ*) cannot be stated, the periodical in question not being accessible for reference. Lastly Frank in the Botanisches Centralblatt, Vol. I, p. 186 (1880), states that he has found *Urocystis Cepulæ* near Leipsic.

Origin.—It seems probable therefore, from the above facts, that the onion smut may be indigenous in Europe, despite the circumstance that the first economic and scientific notices of it are of American origin; nor is it unlikely that, as in the case of so many other plants of a similar nature, it may be a native of both continents. The fact that it has so far been found only on the cultivated onion, renders its origin in nature a matter of doubt; yet since new forms of fungi are being continually brought to light and described as new species, it can hardly be doubted that the onion smut has been similarly overlooked in a state of nature and will ultimately be found on some wild species of onion. A case in point is furnished by the smut on the common yellow Star grass (*Hypoxys erecta* L.) referred to subsequently, which belongs to the same botanical genus (*Urocystis*) with the onion smut; and, although it is conspicuous, and preys upon a host plant of common occurrence, has never been observed, apparently, previous to the past summer, when it was found in abundance near New Haven. It is quite safe to assume then, that the onion smut originates from some wild species of onion, since it is well understood that fungi, like other plants, are no exception to the universal rule that every organism is derived from other organisms like itself, and not spontaneously evolved from "ground" or other substances; an idea much too common, the only foundation for which rests on the ignorance of those who entertain it.

The only other hypothesis in regard to the origin of the onion smut is derived from the fact that two species of smut, belong-

ing to the same genus *Urocystis* (*Urocystis magica* and *U. Colchici*) and parasitic upon wild onions or allied plants, have been described in Europe, and are considered by some botanists to be identical with the smut of cultivated onions (*Urocystis Cepulæ*) which they hold to be merely a varietal form induced by the differences in the host plants. Neither of these European forms are, however, found in America and their structural differences are, moreover, apparently sufficient to separate them specifically from the plant we are considering.

A word may be said here in regard to the popular notion which considers "smuts" of all sorts as identical, however diverse their host plant or mode of attack may be. It is not an uncommon idea, for example, that the smut of indian corn (*Ustilago Maydis* (D. C.)) or of oats (*U. segetum* (Bull)) does not differ from that of onions, and that one disease may be derived from the other. A reference to figures 1, 15 and 16 of Plate II in the present Report, representing the spores of the onion, corn and oat smuts respectively, should convince the most skeptical of the error of this supposition, especially when it is understood that the differences there represented hold good the world over.

General Characters.—The presence of smut in onions is first indicated by one or several dark spots at different heights in the leaves of seedlings, which are seen to be more or less opaque when the plant is held up to the light. These dark appearances may be seen in the first leaf, before the second leaf has begun to develop at all, and are more commonly found just below the "knee"; though they sometimes occur above it. After a time, usually while the second leaf is developing, longitudinal cracks begin to appear on one side of these spots, which widen and show within a dry, fibrous mass, covered with a black, sooty powder made up wholly of the ripened fruit or spores of the fungus, which are blown or washed out onto the ground. In some cases the smut may appear only toward the upper end of the first leaf, and become cut off from the main body of the plant by the withering of the former. In such a case an onion which has shown smut in its first leaf appears, in some instances, to recover, showing no signs of smut in its subsequent growth: but as a rule the same dark appearance shows itself in the second leaf and those subsequently formed, and if the seedling is pulled up and examined, the whole plant will be found to be pervaded by the disease to a greater or less extent. Plants thus diseased, especially if

the soil is dry, very commonly succumb early, dying while in the second or third leaf. The stronger plants, however, especially if the ground is moist, are able to resist the smut sufficiently to make a considerable growth, and many survive even up to the time of harvesting. Fig. 17, on Plate II, represents such an onion reduced to one-third its natural size, and is a typical example of the appearance presented by smutted onions that have survived until midsummer. In such specimens the smut shows itself by black elevations upon the bulb, running down to its very base, and extending upward into the leaves, the outer of which, in the present instance, have split open showing the characteristic sooty powder composed of spores mingled with the stringy mass of dead leaf tissue. As a rule such onions always die, either drying up or rotting soon after they are pulled: the popular belief that smutted bulbs frequently occur among onions after they are housed, resting apparently on the existence of an entirely different disease, subsequently described (p. 161), common on housed onions; but having no connection whatever with the smut, which it resembles only by its black color.

Distribution and Severity.—Although the information obtainable on this subject indicates that the onion smut occurs in Massachussetts, Ohio and Pennsylvania, if not in several other states, Connecticut appears to suffer more from this disease than any other locality, and although, as above mentioned, the necessary data were not obtainable for any exact statement of its local distribution, it may be said, in a general way, that the famous onion districts at or near Wethersfield and Southport, together with that portion of the state lying on the Sound between New Haven and the mouth of the Connecticut river, are the most seriously affected. Mr. S. B. Sherwood, for instance, of Greens Farms, estimates the amount of good onion land which has been given up on account of smut in that town and its vicinity to the east and west, at several thousand acres; and the amount of land at present running out from this cause is considerable.

The severity of the disease in different localities is variable. It appears at first in isolated spots here and there in a field, and from these spreads in all directions until the whole piece becomes affected, and the cultivation of onions upon it has to be discontinued. This period from the first appearance of the smut to the enforced discontinuance of the onion crop, appears to be, on new ground, never less than five years, which is the shortest ascertained interval.

Conditions Influencing Prevalence and Increase.—The prevalence of smut in onions appears to be only slightly, if at all, influenced by general conditions of weather: those which favor the germination and growth of the onion seed affecting the smut spores in exactly the same way. As will be subsequently seen, the period during the germination and earliest growth of the onion seed is the only one during which climatic conditions would be likely to have the smallest influence upon the general prevalence of the disease: since it appears to be at this time only that the fungus threads, developed from the spores, make their entrance into the onion seedling. Having once established itself within the tissues of its host plant, the smut would be developed or retarded by conditions of weather, in about the same ratio that the growth of the onion within which it was present, was developed or retarded. The general opinion, however, that the prevalence of smut in a given field is variable during successive seasons, that is that it does not always show a decided increase, seems to indicate that the conditions of weather at the critical period mentioned may have some influence in the matter.

The influence of soil upon the prevalence of the smut seems inconsiderable, although onions grown in warm light soils are usually more likely to be smutted than if they are grown in heavy, wet land. It should be mentioned, however, that whenever onions grown on low land receive the surface wash of adjacent smutty land, they show an increase of smut proportional to the amount of wash to which they are subject: in other words proportional to the increased number of smut spores, planted among them as it were, in this way. This circumstance may account for the popular impression that low land is more susceptible to smut, whereas, as just mentioned, the reverse is doubtless true.

In regard to the influence of fertilizers, little can be said. The notion that potash fertilizers form smut, and that its appearance was simultaneous with, and in any way attributable to the use of wood ashes, has no logical basis to support it, and is doubtless wholly unfounded. Whether fertilizers rich in nitrogen may be found to favor the growth of smut, is a question which may perhaps be examined with profit.

It was thought possible that the date of planting onion seed might have some influence on the prevalence of smut in a given piece; on the supposition that the smut spores having hibernated might, on the advent of warm weather, germinate at somewhere

about the same time; and that matters could perhaps be arranged so that, either by very early planting the onions might get ahead of the smut, or by late planting the reverse might happen. In practice, however, this was found to be a matter of no importance, as will be seen from the results obtained by successive plantings from May 3d to June 18th, the onions resulting even from this last planting showing 40 per cent. attacked by smut.

Little can be said concerning the comparative liability to smut of the different varieties of onions. But it seems undoubtedly true that the yellow and especially the red varieties are less susceptible than the white to this, as to most other diseases affecting the crop.

Dissemination.—The popular impression that smut is disseminated principally in the planted seed is one which is quite erroneous. As a matter of fact seed onions are not attacked by smut, and the presence of smut spores *in* the seed is not to be considered for a moment as a cause of its dissemination. It is very probable, however, that smut may in some instances be carried *on* seeds grown in smutted districts, the spores adhering to their surface as any small particles of dust might do. Any course of procedure in harvesting or in preparing seed which involved the dusting of even a small amount of smutted earth upon it, would render the seed dangerous for this reason. Proper care in gathering and handling seed should, however, obviate this danger entirely.

The local dissemination of smut is due to four principal causes. First, through agricultural implements; plows, harrows, weeders, rakes, etc., which spread the soil containing smut spores, both by scattering the surface earth over a smutted field and, unless they are thoroughly cleaned, by carrying earth containing smut spores into fields subsequently worked upon. Secondly, through the adherence of the same smutted earth to the feet of men and farm animals and its consequent transportation from one part of a field to another or to different fields; an agency by no means unimportant. Thirdly, the smut spores may be readily washed with surface earth from higher to lower ground, as is a matter of common observation. Fourthly, popular opinion to the contrary, the spores being practically imponderable may be readily blown, with other dust-like material, either about the same field, or into adjoining fields. The reason that this mode of dissemination is of less importance than some others, lies probably in the

fact that the spores being formed and making their exit from the onion comparatively near to the ground, are readily washed into it by rain, and have little opportunity for blowing directly into the air as is the case with corn smut, for example.

It may be mentioned here that the smut appears to be very attractive to the "flea beetles" which swarm over the ruptured parts of diseased seedlings and apparently feed upon the spores, although they do not seem to trouble the healthy onion leaf. That these or other insects may serve to spread the smut in a way similar to that observed in some other fungi, is not impossible.

Retention of Germinative Power by Spores.—It is well known that the seeds of flowering plants may retain their germinative power for a protracted period. For although the reported vitality of "mummy wheat" taken from Egyptian tombs is now wholly discredited, it has been shown by actual experiment that certain seeds will germinate after forty years or more, and a like retention of vitality is to be looked for among many spores of fungi.

The spores of the onion smut, as will be subsequently seen, are by their structure peculiarly well adapted to retain their vitality for a considerable period. To ascertain the actual duration of this period is a matter of considerable importance in considering measures for dealing effectively with the disease, yet, as will be seen, it cannot be used in practice as a means to this end. Prof. Farlow, in the paper already referred to, concludes, as a result of the information on this question given him by farmers and corroborated by the observation of Wolff upon the subject, that the power of germination in the spores of onion smut and other smuts of the same genus (*Urocystis*) endures probably not more than five years. If this were the case it would be obviously no very difficult matter to kill out the disease by putting all smutty land down to other crops than onions for five years. That this period is not as short as five years seems beyond question, as may be seen from the following instance, which appears to be well authenticated. A field on the farm of Mr. Austin Jennings at Green's Farms, was examined with some care in the summer of 1888. According to the positive statement of Mr. Jennings, corroborated by others present at the time, the field in question had not been sown with onions since 1876, the exact date being remembered from the fact that it was in "centennial year" that the piece, having be-

come badly run out by smut, was put down to onions for the last time. Yet after a lapse of twelve years, a careful examination showed that from ten to fifty per cent. of the onions were smutted in the more seriously diseased portions of the field, at a time, moreover (midsummer), when a large number of plants must have been already destroyed and have disappeared. This circumstance points to the fact that the time during which the smut spores *may* retain their germinative power is much longer than twelve years, and that statements which place the period at twenty or twenty-five years may not be greatly exaggerated. At all events abundant evidence on the subject shows that four or five years is a period wholly insufficient to eradicate smut from land or even, in many cases, sensibly to diminish its virulence.

In regard to the influence which certain crops may have upon the period during which smut may remain in land, no definite information has been obtainable, either from personal observations or inquiry; and opinion seems equally divided in its preference for hoed crops or grass, as far as concerns any influence they may have in the matter. Theoretically, there can be little question that hoed crops should be more effective for this purpose since, in all probability, the spores which lie deepest remain dormant for the longest time; and the more thoroughly and often the earth is worked over, the more spores will be brought near the surface into a position where they would naturally germinate. For practical purposes, however, the inquiry seems almost superfluous, since, whatever the nature of cultivation on smutted land, the endurance of smut is so protracted that discontinuance of the crop cannot be considered a *remedy* of any considerable value; but rather a confession that there is no remedy. In saying this, it should not be inferred that such discontinuance and the transfer of the crop to "new" land, is not by all means the best mode of procedure as soon as the smut becomes serious.

Occurrence or Non-occurrence in Sets and Seed Onions.—This question, which is of the utmost importance in suggesting a practical basis for the treatment of smut, is one on which onion raisers seem to have the most diverse views. Careful personal observations, however, indicate that smut does *not* occur either on sets or seed onions. In very rare instances, when smut has hibernated in a comparatively sound bulb which has thus been set out already smutted, it may possibly occur; but as a matter of fact not a single example of the kind has been observed. The common oc-

currence of smut in "small sets," it need hardly be mentioned, has no bearing whatever on the point in question, since it would be even more likely to appear among them (as a result of thick planting) than it would upon onions cultivated in the usual manner for the annual crop. The suggestion may not be out of place here that the opinion contrary to the conclusion above expressed in regard to this matter, which amounts to a conviction in the minds of many onion raisers, rests upon the belief that blackness of any kind upon onions is attributable to smut—an idea which is quite erroneous.

Botanical History and Relations.—The group of fungi to which the onion smut belongs, together with such well known diseases as the smut of corn and oats, the "bunt" of wheat, etc., constitute a family of plants known as the *Ustilagineæ*, several hundred species of which are recorded from different parts of the world, the majority of them characterized by the production of soot-like masses of spores as in the familiar instances just mentioned. Although this smut-like material has, in most cases, very much the same appearance to the naked eye, the spores of which it is composed vary very greatly in size, shape and appearance, in the different genera and species into which the family has been divided. The smut of onions, as has been previously mentioned, belongs to the group or genus *Urocystis*, so named from the fact that it produces spores which are furnished with bladder-like appendages, such as are represented on Plate II. About twenty or twenty-five species of the genus are known on various plants from different parts of the world; but in all cases the spores have the same general characters, consisting of one or more central, dark, thick-walled, nearly spherical so-called resting spores (Plate II, fig. 2 x), surrounded by a variable number of bladder-like bodies, the so-called *pseudospores* (fig. 2 x'), with thinner and more transparent walls. It will thus be seen that each individual particle which goes to make up the black smut-like substance which is the visible product of the disease, is in reality an aggregation of bodies which may, like the onion smut spore, consist of a single central resting spore, surrounded by a number of pseudospores (Plate II, figs. 1, 2, etc.); or may be made up of as many as twelve or fifteen of these resting spores surrounded by a very large number of pseudospores, as in the smut of "star grass" (fig. 14); so that each particle of smut has been called a *spore ball.* The specific differences, that is the differ-

ences which enable us to separate one species of the genus *Urocystis* from another, rest mainly on the number and size of the resting spores and pseudospores respectively, which make up these spore balls in any given species.

As has been already mentioned, the smut of onions first appears to the naked eye as a dark area in the leaf, which finally bursts, letting out the black powdery mass of spores. As the diseased onion grows, unless it is killed when young, the same dark areas begin to appear on the bulbs between the veins, and extend up through all but perhaps the inner leaf as in Plate II, fig. 17; and if the onion is cut in two horizontally, it will be found that the outer "layers" are smutted to a greater or less depth, the inmost layers being often quite sound. If a thin section of a diseased part is cut and placed under the microscope, the black portions will be seen to be wholly composed of spore balls such as have been described above, which, in the onion smut, consist of usually a single, brown, thick-walled resting spore, surrounded by a variable number of pseudospores, often as many as twenty, which are quite regular in shape and size, nearly colorless and spherical, and flattened on the side by which they adhere to the resting spore. Rarely the spore ball may consist of two central resting spores instead of one; but this is exceptional. The enormous numbers of these spore balls that are produced in a single spot of smut may be imagined when we consider that the diameter of each spore ball is not more than $\frac{15}{1000}$ of an inch.

If the section examined is cut so as to include some of the living leaf tissue on the edge of the diseased portion, the origin of the spore balls may be readily seen; for this tissue will be found to be penetrated by a mass of slender fungus threads (*hyphæ*) that push their way between the cells of the leaf which they finally destroy, and as they grow give rise to the spore balls, disappearing themselves soon after the latter are formed. Figs. 24–28 on Plate II, represent the early stages by which the spore balls are formed from the hyphæ. In a general way this formation may be said to consist in the production of two or more lateral out-growths from the hyphæ, one of which assumes a more or less spherical form, while the other or others, as the case may be, grow around it; becoming branched and divided into joints which finally become rounded off into the more or less separate, bladder-like pseudospores already described. The details of this process are a matter for technical inquiry; and it

is sufficient to say in brief, that the resting spore originates as a short lateral branch from a hypha, and that the pseudospores originate from other branches which grow out and surround it.

After it is mature the spore ball appears to pass through a dormant period, at least in a majority of cases, since repeated attempts to induce them to germinate, when fresh, by placing them in a moist atmosphere or in water, proved wholly unsuccessful. Germinating spores were, however, obtained in abundance from material collected in the summer and kept until January for hot-house experiments. A mass of smutted onions was left spread out in a shed for about six months, after which it was mixed with a little earth, saturated with water, and allowed to freeze hard for a week or more. After this treatment some of the smut, removed to a warm room and kept moistened, germinated quite rapidly in the fashion represented in figures 19–21 of Plate II. This germination consisted in the production from the central resting spore of usually a single short hypha of germination, which commonly branched more or less and produced, terminally or laterally, small secondary spores, the so-called sporidia (x, x), as indicated in the figures. The germination of the spores in this species has not, apparently, been previously observed, and, as will be seen from the figures, differs somewhat from the conventional form described as characteristic of certain other species of the genus; which consists in the production of simple, stout, short hyphæ from the resting spores, bearing at their summit a whorl of sporidia. This condition is approached in fig. 19, where the hypha bears two sporidia at its extremity: but this variation, which was only seen in a few cases, is manifestly merely a form of the others. In a nutrient solution, for which a decoction of onions was employed, in Van Tieghem cells, the hyphæ of germination grew very rapidly, and branching and extending themselves in all directions, also bore numerous secondary spores (fig. 18, x, x,) similar to those produced in ordinary germination, except that they were larger. These secondary spores correspond to similar forms obtained by Brefeld in his cultures of other genera of Ustilagineæ and termed by him conidia, although they appear to be in reality merely luxuriantly developed sporidia. The secondary spores or sporidia, germinated readily in water or in nutrient solutions (fig. 23): but it was impossible to observe their further development owing to the fact that the material for cultivation could not be obtained

pure, and for this reason all the cultures swarmed with bacteria and were soon destroyed by them.

Absolutely pure cultures of fresh spores taken directly from the living leaf, as well as of small clumps of sporiferous hyphæ, similarly obtained, were, however, very readily made in the same decoction of onions, and grew with a luxuriance which was proportional to the concentration of the nutrient solution. Out of a very large number of such cultures, made in Van Tieghem cells, not a single one produced spores or sporidia of any kind, merely developing abundant branched and septate hyphæ, extending in all directions, and stout or attenuated according to the concentration of the decoction. The clumps of hyphæ, which were in process of forming spore balls when taken from the living onion, acted in exactly the same manner as did the spore balls themselves, producing no sporidia and ceasing to produce spore balls. Similar cultures, both of spore balls and of sporiferous hyphæ, made in sterilized flasks plugged with cotton, also produced nothing but sterile hyphæ which, after forming a spherical mass a quarter to a half an inch in diameter, gradually died without further development. It may be mentioned here that in none of the cultures was any yeast-like development noticed, similar to that described by Brefeld in other instances.

We have in New England four species of smuts belonging to the genus *Urocystis:* namely, *U. Cepulæ* Frost on onions, *U. Anemones* (Pers.) on Wood anemones, *U. occulta* (Rabh.) on rye, etc., and the form previously mentioned on Star grass (*Hypoxys erecta*) which appears to be undescribed. Figures of the spores of all these species are given on Plate II for comparison. *U. Cepulæ* resembles *U. occulta* more than the others; but is separable from it at once by the fact that the spore balls of the latter species (fig. 9) are composed of two or three resting spores more commonly than of one; while those of the former have two only very rarely, and never three. *Urocystis Anemones* differs from the smut of onions by the larger size of pseudospores and resting spores, as well as by the smaller number of the former. Lastly the *Urocystis* of *Hypoxys* (figs. 12–14) is at once separable by the large number of resting spores (one to fifteen) which may be present in a single spore ball.

It is therefore out of the question to suppose that the smut of onions may be merely a form of one of the other species of *Urocystis* found in New England: but when we turn to Europe,

the number of species is greatly increased, there being about twenty in all, and of these three (including our species) grow upon members of the genus *Allium* to which the onion belongs. One of these, *Urocystis Colchici* (figs. 3–4) attacks *Colchicum* and allied plants and is said to occur on some members of the genus *Allium*. The other, *Urocystis magica*, occurs in Italy on *Allium magicum* where it was collected by Prof. Passerini and distributed, as already mentioned, under the above name in Thuemen's Mycotheca Universalis, No. 223, from which figs. 5–6 were derived. In the article of Cooke already cited, *U. Cepulæ* is considered merely a variety of *U. Colchici*, while Winter in his Pilze, p. 120, goes still further and unites all three under *U. Colchici*. Since, however, a discussion of specific identities would be out of place here, although interesting as a possible means of determining the origin of the onion smut, it need only be said that an extended examination of unlimited material shows that the onion *Urocystis*, as it occurs in Connecticut, is a well defined form, subject to very slight variations. While *U. magica* resembles it in having a single resting spore and numerous pseudospores, which are very regular in size and shape, its resting spores and and pseudospores are much larger than those of the american species: which also differs from *U. Colchici*, on the other hand, by its smaller regular pseudospores and single resting spores.

Manner of Infection.—So far as is known, then, the life history of the smut fungus is sufficiently simple. The resting spores commonly after remaining dormant for a time, which may according to circumstances extend over a period of years, germinate, giving rise to one or more hyphæ of germination. There is no reason to suppose that these hyphæ may not enter the young onion plant directly: but more commonly this is doubtless accomplished through the medium of the secondary spores or sporidia, already described as produced from them, which germinate in their turn (fig. 23), sending out a hypha which may enter the young onion directly. The chance of infection is thereby increased in a ratio almost equal to the number of sporidia formed. When it has once penetrated the host plant the hypha of germination branches and extends itself within it, ultimately producing, in the way already described (figs. 24–28), spore balls similar to that from which it sprang: thus completing the history of its development.

In considering any means of direct treatment against the onion smut, it is of the first importance to know this history as

accurately as possible in its details. It is well known that the treatment of smuts, which attack the reproductive organs of plants, like the "bunt" of wheat, is a matter of no great difficulty; since in the majority of such cases, infection takes place through the seed, for the reason that the smutted heads are harvested and threshed with the sound ones, so that more or less of the seed is sure to have smut spores adhering to it, and thus placed in a position to produce infection at germination in a large number of cases. Treatment of such seed, before sowing, with a solution of sulphate of copper or strong brine, seems to have been found effectual in checking the smut of wheat; but in the case of the onion smut we have a very different state of affairs. In this case the danger from spores adhering to the seed is slight, the infection coming from spores mixed in with the ground in which the seed is planted. It is therefore necessary to ascertain whether the resting spores germinating on or near the surface of the ground, produce sporidia which blow onto the onion plant and enter it, after it has emerged above the ground, or whether this entrance is effected wholly under ground, and if so, under what conditions. In one species of *Urocystis* (*U. Anemonæ*) it has been shown that sporidia, sown upon the leaves of the host plant, will infect it with this smut at the point of application; at least Dr. Plowright in his "British Uredineæ and Ustilagineæ" (p. 94), claims to have shown this experimentally. Again Cornu (Bulletin de la Société Botanique de France, 1880, p. 39–42), states that seedling onions infected with the spores of *Urocystis Cepulæ* died "probably" from this cause. In the case of certain other members of the family it has been shown definitely, however, that the infection of the host plant takes place under ground, and it seems hardly a matter of doubt, despite the questionable observation of Cornu just cited, that the same is true of the onion *Urocystis*.

Experimentally this was indicated, if not proven, in the following manner. A cylindrical glass jar was employed for the experiment, in the bottom of which was placed about an inch or two of ordinary earth of an even depth. On this was scattered a thin coating of the smut from which the germinations previously described were obtained, and into this were lightly pressed several dozen seeds of white onion. Over this was placed a layer of sterilized earth, one and a half inches thick, and the jar was then placed under a bell glass and kept in a warm room. The onions came up rapidly and while in the second leaf were

with hardly an exception, killed by smut; the characteristic dark areas appearing in the first leaf soon after it rose above ground. In view of the common idea that smut is in the seed of onions, the same experiment was duplicated, omitting the layer of smut, the resulting seedlings showing no signs of smut whatever.

The fact of this subterranean infection is further confirmed by the absence of smut on sets and seed onions, as well as on transplanted seedlings; for if the young tender leaves above ground were susceptible to infection, smut would certainly occur in these cases. It may then be assumed with tolerable safety that the smut makes its entrance into the onion seedling in the ground. It may be asked, however, if this is the case, why it does not enter sets, seed onions and probably seedlings, when they are transplanted into smutty ground. The explanation of this must be sought in the fact that some plants are susceptible to certain diseases only at certain periods of their existence. For example, it has been shown that a common form of mildew (*Cystopus candidus*) which attacks the common Garden cress (*Lepidium sativum*) and its allies, is able to infect this plant only when it enters it through the first leaves or cotyledons, the hypha of germination being unable to establish itself within the plant at other points; so that when the cotyledons have withered, there is no further danger of infection. It is not improbable then that the relation of the onion seedling to the germinating smut spore may be somewhat similar. Certain observers have claimed in the case of other smuts that the hypha of germination enters the so-called collar of the embryo, where root and stem meet. This may be the case in the onion smut, yet that it also enters the first leaf seems indicated by the occurrence of isolated points of infection at its apex.

Experiments for Prevention.—Assuming that the mode of infection above described is correct, it is obvious that, in considering any means of treatment by fungicides, the usual external applications would be quite useless. The fungicides must evidently be employed so as to act under ground during the period of germination of the seed. This may be effected either by applying some substance as a top dressing and brushing it in so that it would lie in the earth about as deep as the seed was planted; or by sowing it in the drills with the seed. The first method is manifestly undesirable on account of the much greater expense involved, both in labor and cost of material used. The second, involving no labor beyond the preparation of material and about one-tenth

the amount of this material, is manifestly the only one to be considered.

Having determined on the method of application the next and most important point is to ascertain what substance will be the most effectual and cheapest for the desired purpose. In order to test this question, two sets of experiments were tried; one during the late winter and early spring in a box bed in the hot-house; the other at Green's Farms on a small piece of very smutty ground.

The first of these experiments it is hardly necessary to describe in any detail, since it was made merely to gain suggestions for the second. It is sufficient to say that fifteen rows, four feet long were planted, of which seven were treated with sulphate of iron, five with sulphate of copper, three left untreated and one planted with treated seed. The chemicals were sown on the surface of the drill in one half of each row, and in the drill in the other half. The seven rows treated with iron sulphate received applications of 4, 5, 7, 8, 9 and 12 grammes respectively. Those treated with copper sulphate had 3, 4, 4½ and 5 grammes respectively. The surface application had not the smallest effect of any kind, in either instance. The application of sulphate of copper in the drill killed a large percentage of the seed and produced no diminution in the percentage of smut. Even the large amount (twelve grammes) of sulphate of iron did not hinder germination perceptibly, and appeared to decrease the number of smutted plants decidedly. In a single row, one-half the seed was rolled, before planting, in sulphate of copper; the other half in sulphate of iron. In the first instance every seed was killed, while the iron did not hinder germination and slightly decreased the percentage of smutted plants.

The experiment therefore indicated that although sulphate of copper was quite worthless both from its injurious effect on the seed, as well as from the fact that it produced no diminution in the amount of smut, sulphate of iron appeared to have an appreciable effect against the smut while not hindering germination in the least. Surface applications of the same salts was also found to be without effect; although thoroughly washed in by constant watering.

The second experiment was tried upon very smutty ground which was hired from Mr. Austin Jennings of Green's Farms, and was wholly run out by smut in the previous year. The

experimental piece was 120 feet long by 10 feet wide; the rows, running transversely, ten feet long and one foot apart. Every alternate row was left untreated for direct comparison with the treated row next it. Weighed amounts of seed were planted in each row, about ten to the foot, and at the same time the drills in which the seeds were sown were treated with certain chemicals, in sets of five each, making in all ten rows to each set, five treated and five alternate untreated. There were in all twelve of these sets, including one set of five rows planted in ground previously top dressed with sulphate of iron, in which the control rows had of course to be omitted. The chemicals, which were in the form of powders, were scattered by hand along the drills, slightly mixed with the soil and the seed then planted and covered. The substances used and the amounts per row are shown in the subjoined Table. The rows treated with "Patent germinator" were planted with seed that had been soaked according to instructions which accompanied a sample of the material, "New Preserver and Germinator of Cereals and Seeds of all Kinds," received and analyzed by the Station. One of its "notable advantages" being that it is said "to destroy insects and act effectually on the globular formed dust which participates in the formation of blight, of heat, of ergot of rye, etc.," a trial in the case of onion smut was suggested. Analysis of the article in question showed it to be an impure acetate of lead, a substance of which the fungicidal properties have not apparently been tested. The results given in the table do not seem to warrant its general adoption as a nostrum for "globular dust" or to secure an increased germination of "from 20 to 25 per cent." in the case of onions at least.

The onions came up, for the most part, during the first week of May and showed abundant evidences of smut by May 10th, while still in the first leaf. A considerable number were killed in the second leaf, a few even before this. By May 18th, when the onions were examined, the different appearance of the treated and untreated rows in some of the plots began to be apparent, and by the first of June was very marked. Those treated with sulphur and lime and with sulphide of potassium were not only visibly thicker, but much taller and healthier in appearance than the alternate untreated rows. There was also a visible, though not so striking, difference in the sets treated with hyposulphite of soda. The sets treated with iron showed no appreciable differences between the treated and untreated rows, while the copper

application was evidently injurious in both cases, the detrimental effect upon the onions themselves not being compensated for by any appreciable action on the smut.

During the summer the smutted onions died off slowly, although a considerable number survived up to the time when they were pulled (Aug. 6). At this date the number of sound onions remaining in each row is shown in the table; but owing to an accident the correct weights of those sets, only, were obtained, which had been treated with sulphur.

	Number of grammes used per row.	Average No. of plants per row, May 11.	Average No. of *sound* onions per row pulled Aug. 6.	Av. weight per row of sound onions weighed Aug. 9.
Top dressed with sulphate of iron	30	98.8	11.6	....
Seed treated with "Germinator"		100.2	8.4	....
Alternate rows untreated		95.	7.2	....
Sulphide of sodium in drills	10	90.8	29.8	....
Alternate rows untreated		98.	11.6	....
Sulphide of sodium in drills	5	98.6	38.8	....
Alternate rows untreated		103.2	6.4	....
Hyposulphite of sodium in drills	20	73.2	11.2	....
Alternate rows untreated		99.6	7.4	....
Hyposulphite of sodium / Air slaked lime } in drills	10 / 10	90.6	27.	....
Alternate rows untreated		101.2	10.	....
Flowers of sulphur / Air slaked lime } in drills	10 / 10	106.6	35.4	70.8
Alternate rows untreated		96.4	9.	16.4
Flowers of sulphur / Air slaked lime } in drills	5 / 5	100.4	31.6	58.4
Alternate rows untreated		91.	4.8	2.4
Sulphate of copper / Air slaked lime } in drills	10 / 10	71.4	17.4	....
Alternate rows untreated		91.6	10.	....
Sulphate of copper / Air slaked lime } in drills	5 / 5	84.2	10.	....
Alternate rows untreated		94.	6.2	....
Sulphate of iron in drills	20	72.2	58.6	....
Alternate rows untreated		89.	24.	....
Sulphate of iron / Air slaked lime } in drills	5 / 5	78.2	38.6	....
Alternate rows untreated		78.6	37 8	....

It will be noticed that the amount of smut in different parts of the piece varied very considerably, as indicated by the number of plants killed in the alternate rows, the rows towards the edge of the field being the least affected: but even including these, the average number of plants killed amounted to nearly 90 per cent. in the untreated rows. It is assumed that all the deaths were due to smut in making this statement. As a matter of fact the onions were carefully examined weekly during the first two months or more of their growth, and although a few cases of death from other causes were noticed, such instances were rare.

However unsatisfactory the result of the experiment may seem as shown by the figures in the appended table, the negative results are at least conclusive in some respects. It is quite evident that a remedy is not to be sought in sulphate of copper, since an application sufficient seriously to affect the germination of the seed, showed no appreciable influence upon the amount of smut. Sulphate of iron also may be discarded for the purpose in view, and the results with hyposulphite of sodium are so much inferior to those obtained with sulphur and sulphide of sodium that it also need not be considered. Having narrowed our consideration down to sulphur and sulphide of sodium the matter is further simplified from the fact that the former is far less expensive than the latter, as well as for the reason that the sulphide is much more difficult of application owing to its deliquescence when exposed to air; which was, however, obviated in the present case without much difficulty by mixing it with dry earth before applying. Since the results with the sulphide of sodium were little if at all better than those obtained with flowers of sulphur, it may also may be excluded, from the trouble and expense involved in its application.

Of the substances used then, flowers of sulphur is the only one which merits consideration from a practical standpoint, and the question remains: do the results of the present experiment point to the conclusion that treatment with this substance may be made of practical value. It will be noticed that in the final result the relative proportion is very much in favor of the smaller amount of sulphur notwithstanding the fact that no injury to the seed resulted from the larger application. The reason for this discrepancy probably lies in the fact that the smaller amount was scattered more evenly in the bottom of the drill, and the seed planted almost directly upon it; while the larger amount was

mixed in with the earth before the seed was planted, so that a more direct application about the seeds resulted from the smaller than from the larger amount. The same may be said in regard to the application of sulphide of sodium, the results of which show a similar discrepancy in favor of the smaller amount. It may be therefore inferred that a slight variation in the manner of application may have a considerable influence upon the effect produced, and that better results are to be looked for from a more precise application of the fungicide.

Although the treatment with flowers of sulphur cannot now be recommended, it is hoped that the experiments of another season may give results sufficiently good to warrant such recommendation. It must be confessed that the present experiment was undertaken with but small hopes of any results whatever, beyond such as might be of negative value; and however unsatisfactory the actual outcome may appear, as regards the amount of sound onions that may be grown on the smuttiest land when treated as described, it is at least gratifying to have accomplished anything in a preliminary investigation, based largely on theoretical considerations, and unassisted by the results of any previous experiment similar to it.

As a comparative experiment the results are of some interest, since beyond the considerable variations to be noted between the treated and untreated rows in the actual number of sound onions obtained, it will be noticed that the difference in the weights shows a much greater discrepancy. In other words the onions grown in the untreated rows were mostly small and stunted, while those in the treated rows were mostly large fair bulbs.

The figures given on Plate I, represent accurately the appearance of the rows treated with sulphur and sulphide of sodium, as compared with the alternate untreated rows. The figures are direct reproductions from photographs taken on August 6th, after all smutted onions had been pulled both from the treated and untreated rows. The rows therefore represent the appearance of the *sound* onions, in either case, at the time of harvesting.

As has been already remarked the experiment is merely tentative and no claim of practical success is made for it: nor is its trial recommended unless on a very small scale, until it has been tested by another season's work which may give better or not as good results. It is manifestly unsafe to generalize from a single experiment and it can merely be said that flowers of sulphur offer a promising substance for the desired purpose.

Should this mode of treatment ultimately prove sufficiently successful to warrant its recommendation, it may be of interest to note the expense involved if the fungicide is applied by means of a hopper and the smaller amount used. The rows being planted one foot apart the cost *per acre* would be as follows :

Cost of application	$0.00
Cost of flowers of sulphur	.48
Cost of lime	.12
Total cost per acre	$0.60

In addition to the sets of experiments above described a certain number of rows were left at first unplanted. Of these, two were planted on each of the following dates: May 3d, 10th, 18th, 24th, June 5th and 18th, in order to observe the effect of early and late planting as far as it might influence the percentage of smutted onions obtained. Taking the rows in the order in which they were planted, beginning with May 8th and ending June 18th, the percentage of smutted plants in each was as follows : 75 per cent., 75 per cent., 66 per cent., 55 per cent., 50 per cent., 40 per cent. A few onion seeds were also planted in old smutted earth in the greenhouse about the middle of August, and of these also a large number came up smutted, although so many of them were destroyed sooner or later by another fungus (*Pythium*) that the exact percentage was not obtainable.

The above facts indicate that whenever smutted ground is disturbed germination of spores is likely to follow under proper conditions of heat and moisture, and that for this reason any variation in the usual date of planting would be of no advantage in endeavoring to check the disease, especially in view of the fact that the later the date of planting the more inferior are the onions obtained.

General Precautions.—Attention should perhaps be called here to a few general precautions which may be of service against the *Urocystis*, the most important of which have already been referred to in connection with its dissemination (p. 137) by farm implements, etc. Such implements should never be used on smutted ground and then upon new ground, without thoroughly washing off all adhering earth. The same may be said in regard to any means by which smutted earth may be transported.

All refuse of whatever kind that is left on the field should be *burned* as soon as practicable, and although onion land is usually

kept so clean that it cannot be burned over in the fall, this practice will be found very advantageous when it is possible.

At the second and subsequent hand weedings all onions which show smut in the second or third leaf should be pulled, collected in a basket or other convenient receptacle and burned at once. This practice involves very little trouble and the folly of leaving the larger smutted onions to discharge crop after crop of spores upon the ground, as the leaves successively mature, is apparent; especially when the enormous number of spores thus formed is considered. It is hardly an over-estimate to say that a single large onion may mature during a season something like a cubic inch of smut, which means between one and two thousand millions of spores, each capable of producing a smutty onion in the following season.

If an onion grower has unlimited land suitable for the crop it is almost superfluous to say that the best means of avoiding smut is to take up new land as soon as the old shows signs of the disease to any considerable extent; but, as has been previously remarked, this is not a *remedy* for smut, any more than it would be a remedy to stop raising onions altogether in affected sections.

Description of Plate I.

Experiment for the Treatment of *Urocystis Cepulæ* (Onion Smut).

The figures are reproduced from photographs taken directly from the experimental plots August 6, after all smutted onions had been pulled both from the rows numbered 1 to 9, *which received no treatment*, and those lettered A to F, which received treatment.

Rows A, B, C, D, E, were treated with sulphide of sodium, 5 grammes to each row.

Rows F and G were treated with 10 grammes of sulphur and 10 grammes of air-slaked lime each.

Rows H, I, J, received each 5 grammes of sulphur and 5 grammes of air-slaked lime.

Rows 1, 2, 3, 4, 5, 6, 7, 8, 9, received no treatment.

Each row was ten feet long. The upper figure being on a larger scale than the lower presents an appearance of greater vigor due to the enlargement.

PLATE I.

Description of Plate II.

Urocystis Cepulæ Frost (Onion Smut).

Fig. 1.—Spore ball.

Fig. 2.—Spore ball in optical section, x=pseudospores. x'=resting spore.

Fig. 17.—Onion attacked by smut showing appearance in midsummer.

Fig. 18.—Spore germinating in decoction of onion and forming sporidia x.

Figs. 19–22.—Spores germinating in moist chamber, producing sporidia x.

Fig. 23.—Single sporidium germinating in water.

Figs. 24–28.—Sporiferous hyphæ from onion leaf showing successive stages in the formation of spore balls.

Urocystis Colchici (Schl.) Rab. (Smut of *Colchicum*, etc.).

Fig. 3.—Spore ball composed of a single resting spore.

Fig. 4.—Spore ball (in optical section) composed of three resting spores.

Urocystis magica Pass. (Smut of *Allium magicum*).

Figs. 5, 6.—Spore balls composed of single resting spores, one (fig. 6) in optical section.

Urocystis Anemones (Pers.) Schrt. (Smut of Wood Anemone).

Figs. 7, 8.—Spore balls composed of single resting spores, one (fig. 7) in optical section.

Urocystis occulta (Wallr.) Rabh. (Smut of Rye, etc.).

Fig. 9.—Spore ball composed of three resting spores seen in optical section.

Figs. 10–11.—Spore balls composed of single resting spores, one (fig. 10) in optical section.

Urocystis Hypoxys n. s.* (Smut of Star Grass).

Fig. 12.—Spore ball composed of one resting spore.

Fig. 13.—The same in optical section.

Fig. 14.—Spore ball composed of fourteen resting spores (three not shown in figure).

Ustilago Maydis (DeC.) Corda (Smut of Indian Corn).

Fig. 15.—Four spores.

Ustilago segetum (Bull) Ditm. (Smut of Oats, etc.).

Fig. 16.—Four spores.

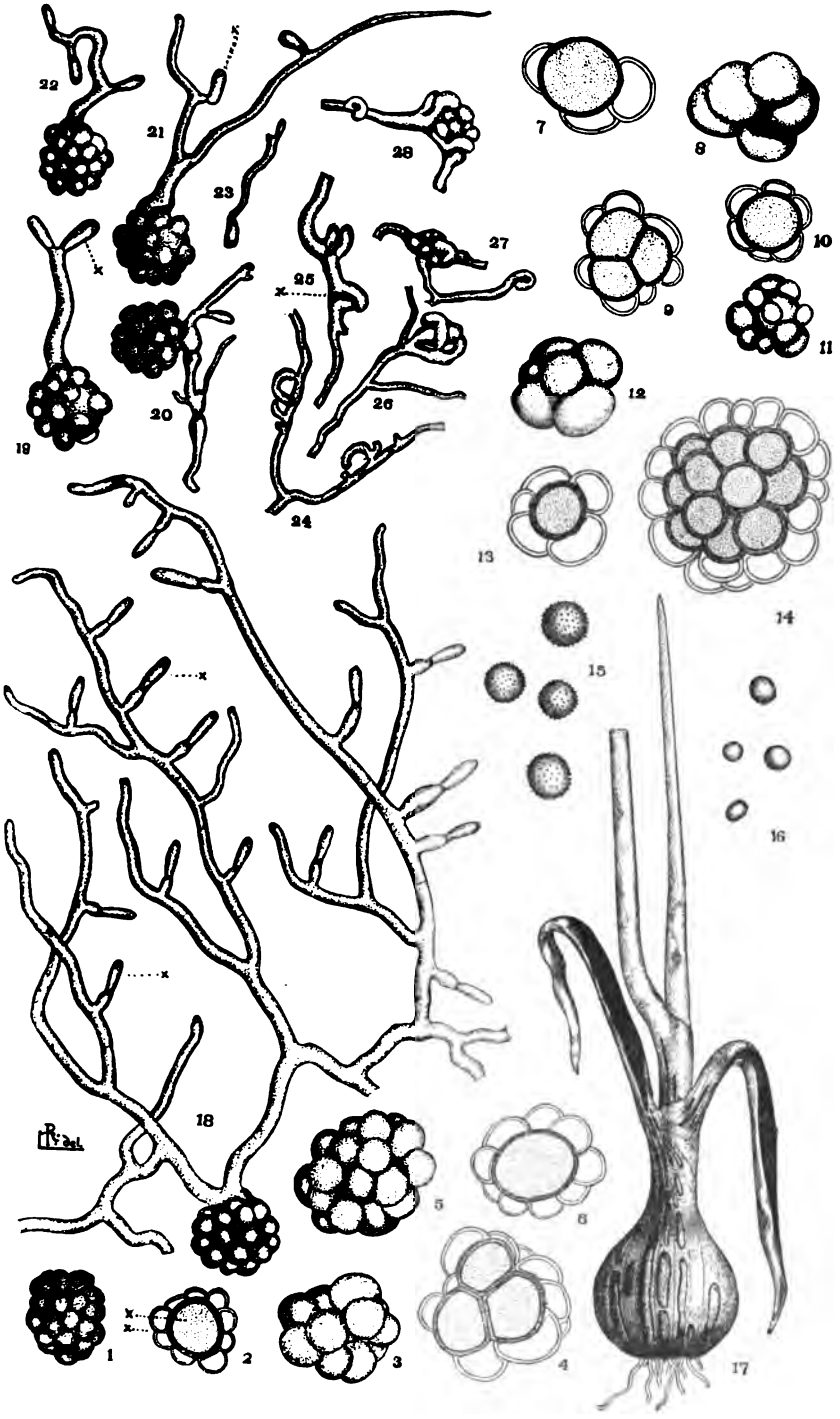
Of the above figures, fig. 17 is reduced to about one-third natural size. The remainder were drawn with camera lucida under a magnifying power of a little less than 700 diameters, the size being reduced in the present photo-reproduction of the original ink drawings, which were $12 \times 7\frac{1}{2}$ inches.

* The smut of Star Grass may be characterized as follows:

Urocystis Hypoxys n. s.

Spore masses black, in flowers (filling ovary), pedicels and peduncles (only near summit). Spore balls very irregular in size and shape, roundish or long-oblong, the largest 50–60 × 50^{mm}, the smallest about 25 × 25^{mm}. Resting spores brown, spherical or somewhat polygonal from pressure, one to ten (rarely fourteen or fifteen) in number, 13–15^{mm}. Pseudospores numerous, where the resting spore is single about eight to ten in number, somewhat flattened, variable. 8–15^{mm} in diameter.—On *Hypoxys erecta* L., June–August, New Haven, Conn.

PLATE II.



Description of Plate III.

Phytophthora Phaseoli Thaxter (Mildew of Lima Bean).

Fig. 29.—Group of conidiophores arising from a common slightly swollen base.

Fig. 30.—Group of conidiophores pushing through stoma of bean-pod, bearing conidia at their tips.

Figs. 31–32.—Conidial spores germinating laterally and terminally and producing secondary conidia.

Fig. 33.—Conidial spore immediately before germination by zoöspores, showing slight lobulation of its contents.

Fig. 34.—Zoöspores making their exit from the apex of germinating conidium.

Fig. 35.—Conidial spore from which the contents has been discharged in an unbroken chain before any of the zoöspores have become motile.

Fig. 36.—Motile zoöspores.

Fig. 37.—Zoöspores which have come to rest, one germinating.

Macrosporium sarcinula Berk., var. *parasiticum* Thm. (Onion *Macrosporium*).

Fig. 38.—Conidiophores with spores *in situ*.

Fig. 39.—Two spores seen in optical section.

Macrosporium Porri Ellis (Larger Onion *Macrosporium*).

Fig. 40.—Conidiophores with spores *in situ*, showing sclerotioid body (x) from which they arise. (From specimen on seed onion stalk.)

Fig. 41.—Spore from seed onion stalk, seen in optical section.

Fig. 42.—Two spores from onion leaves showing extremes of size and shape.

Vermicularia circinans Berk. (Onion *Vermicularia*).

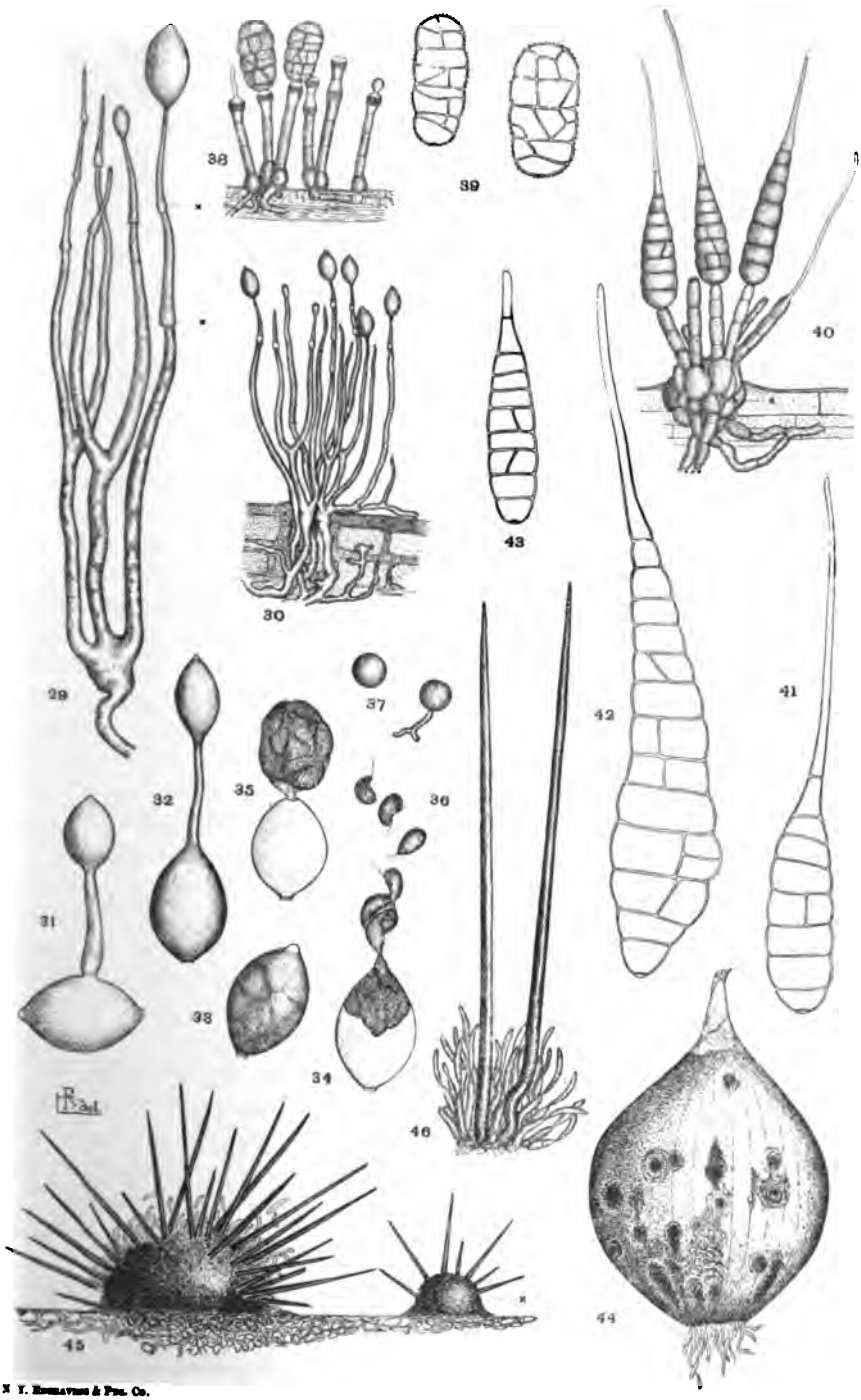
Fig. 44.—Onion bulb attacked by *Vermicularia* in bin.

Fig. 45.—Mature and young (x) "perithicium," the former showing spores lying about the base of the spines.

Fig. 46.—Isolated fragment of the above showing method in which the spores are produced from the tips of the basidia, with two spines showing origin from hyphæ.

The above figures were drawn and reproduced as in Plate II. The magnifications used in the original drawing were approximately as follows: Fig. 29 × 350; Fig. 30 × 136; Figs. 31–37, 38, 41–43, 46, all × 464; Figs. 38, 40 × 232; Fig. 45 × 200.

PLATE III.



N. Y. Engraving & Ptg. Co.

The Onion Mildew (*Peronospora Schleideni* Ung.)

Early in July of the past season, information having been received from Mr. S. M. Wells that a blight of some sort was damaging the seed onions in the town of Wethersfield and its vicinity to a serious extent, a visit was paid to the locality, and a number of fields inspected in company with the above named gentleman. The diseased condition of many of these fields was apparent without close inspection, a large percentage of the stalks in some of them having turned nearly white or yellowish, so as to give to the whole field, or certain portions of it, a decidedly sickly appearance. A closer examination of the affected stalks showed that the trouble originated as a small yellowish discolored patch, usually on one side, from which the disease spread in all directions so as often to involve the whole stalk. The only visible appearance upon the surface was an obscure, mould-like coating, white near the edges of the diseased spot and slightly reddish near the center. This appearance of mildew was also noticeable on such leaves as had not been already entirely killed by it, and was very commonly followed by a velvety black coating, sometimes covering the stalks almost entirely and forming a conspicuous feature in the diseased fields. This black appearance, being due to a fungus (*Macrosporium*) wholly unconnected with the mildew, will be referred to subsequently.

The virulence of the disease varied very greatly, according to the situation of the field attacked, low sheltered ground being the most favorable for its development; while such as were on high land, which admitted of a free circulation of air, were comparatively free from its injury. It was noticeable that, in all situations, only seed onions seemed to be thus injured, and although in many cases seed onions were growing almost side by side with market onions of the same variety, the latter were not attacked in a single instance, as far as observed.

The same locality was again visited a month later when the seed was being harvested, and the serious character of the disease was even more apparent from its effect upon the crop. In one small field especially, it was noticed that apparently not a single pod had properly matured, while in others, not so seriously attacked, not more than fifty per cent. matured any seed. The best of these pods were found to have matured seldom more than seventy-five per cent. of their seed and of this a large percentage was not capable of germination.

A microscopic examination of the diseased stalks gathered in July, showed them to be covered with the fruiting hyphæ of a mildew which was at once recognizable as belonging to the onion *Peronospora* (*P. Schleideni*). The hyphæ of the fungus penetrate the tissues of the host plant, pushing their way between the cells, the contents of which they destroy, and finally make their exit into the air, one to several at a time, growing out through the breathing pores or *stomata* of the host. After making their exit through the stomata, the hyphæ become several times branched, the ultimate branches being somewhat attenuated and curved, and bearing at their extremities large, faintly purplish spores, oval in shape and slightly pointed at either end. The disease is spread rapidly during damp weather by means of these spores, which blow or fall upon neighboring stalks or leaves, on the surface of which they germinate; sending out a short hypha which makes its entrance through the stomata already mentioned and, by its subsequent growth and ramification within its host plant, produces a new centre of disease which spreads as above described; first showing as a yellowish discoloration which may involve the whole or a large portion of the leaf or stalk. This mode of reproduction is designed for rapidly spreading the disease in summer; but like most other fungi, the mildew is provided with still another means of perpetuating itself through the agency of resting spores, or *oöspores*. While the summer spores, or *conidia*, are very short-lived, retaining their vitality at most for but a few days, the oöspores are designed to perpetuate the fungus during long periods while the conditions for its growth are unfavorable. It is by their means that it survives the winter from year to year, and it is probable that, like the resting spores of the onion smut, they may retain their power of germination for more than a single season. Unlike the conidia, the oöspores are formed not on the surface of the host plant, but from the threads which grow within its tissues. They are spherical in shape, furnished with a very thick wall, and often occur in great numbers, although none were observed in the material brought from Wethersfield.

This fungus, which is similar in nature to the downy mildew of the grape (*Peronospora viticola*), is well known in Europe as producing a serious disease of cultivated onions, occurring also on wild species. In this country it has been known to produce injury among onions in Wisconsin, specimens having been col-

lected at Ithaca in that state by Prof. Trelease and distributed by him in Ellis' North American Fungi, No. 1412. During the past season it has also been received from Prof. Farlow on onion leaves sent to him by Mr. Fletcher of the Ottawa (Ontario) Experiment Station. It is therefore, in all probability, widely distributed in this country, although references to its occurrence do not appear to be frequent. It is perhaps best known as a serious disease among onions in the Bermuda islands, where it had become so destructive among market onions in 1886, that the legislature of the colony was induced to apply to England for some one to make an investigation into the cause of the trouble. This investigation was assigned to Mr. Arthur Shipley, and the results of his observations are given in the Kew Gardens Bulletin of Miscellaneous Information, No. 10 (London, 1887).

Although, as already stated, the disease was observed in Wethersfield only upon seed onions, in Bermuda and elsewhere it appears to be most destructive among market onions, ruining whole fields in an incredibly short space of time. Mr. Shipley attributes the severity of the disease in Bermuda partly to the fact that the onion farmers adopt the primitive method of setting out their market onions, thereby weakening the plants: a circumstance which, together with the excessive humidity of the climate, affords very favorable conditions for the spread of the disease.

In regard to remedies against this mildew, preventive rather than curative measures seem to offer the best prospect of good results. Knowing the life history of the fungus, and that it is perpetuated over winter and originates during the following season by means of resting spores, which survive in the dead tissues of the onion leaves and stalks, the necessity for destroying all such refuse needs hardly to be pointed out. The common practice of ploughing in stalks and field refuse generally cannot be too strongly condemned, and in the present instance renders the infection of onions grown on the same land another year almost certain. The stalks should invariably be burned in a manner to render their destruction as complete as possible. The repeated use, for the same crop, of land on which the *Peronospora* has appeared, should be avoided. After a severe attack of this mildew, such land should be used for other purposes for several years; and it may be said in general that in localities where the disease is known to exist the use of low sheltered land should be avoided for this crop.

Should the disease ever appear with severity among market onions, as it is known to do in Europe and the Bermuda islands, it is hardly to be doubted that an application of any of the copper mixtures which have been found so effective against the mildew of the grape, would be equally effectual in the present instance if properly applied. Any application to seed onions would be a matter of greater difficulty, unless the disease should appear while they were comparatively young.

The nature of this injury does not appear to be appreciated in the locality where it was observed and where it is known under the name of "white blast." This is owing to the fact that the mildew itself is very inconspicuous on the stalks; but it should be mentioned here that the term "white blast" is used also to refer to diseases which have no connection with that under consideration. The most serious of them, the "white blast" of market onions, is due to an insect, the onion *Thrips*, which has done the most serious and widespread injury to the crop all over the State (see p. 179). The ordinary whitening of certain stalks among seed onions, which is also known as "white blast," is likewise unconnected with the *Peronospora*.

The Onion Macrosporium. (*Macrosporium sarcinula* Berk.; variety *parasiticum* Thüm.)

PLATE III. FIGS. 38, 39.

It has been already mentioned that, in a majority of cases, the mildew just described was followed by a black appearance, resulting from the growth of a fungus wholly different from the *Peronospora*, namely, the onion *Macrosporium* (*M. sarcinula* var. *parasiticum*). Although more common and conspicuous among seed onions which have suffered from the mildew, this fungus appears to be almost universal among onions in the state, occurring on market as well as seed onions and sets. It is much more conspicuous on the seed stalks than elsewhere, forming a deep black, velvety coating, which sometimes involves the whole stalk. On the leaves it is less conspicuous, often brownish or not so evenly black, and when the mildew has not preceded it, it is less evenly diffused occurring here and there in patches.

Attention was first called to the occurrence of this fungus on onions by Von Thuemen, who described and distributed it as a new species (*Macrosporium parasiticum*) in his Mycotheca Universalis, No. 667, in 1877: the specimens having been col-

lected in Bavaria, where the fungus was stated to be parasitic, for the most part, upon the onion *Peronospora*. The disease is subsequently referred to by Mr. Shipley in the paper already mentioned (Kew Bulletin of Miscellaneous Information, p. 17), in which it is described as prevalent in Bermuda in connection with the onion *Peronospora*. More recently it has been very thoroughly studied in its botanical aspects by Prof. Miyabe (Annals of Botany, vol. III, No. 9, 1889), who succeeded in tracing its life history by cultures, and concludes that it is merely a form of *M. sarcinula* Berk., a species common on various substrata.

As regards its distribution in this country nothing can be said, except that it occurs in Connecticut and Maine, and has been received in company with *Peronospora Schleideni* from Prof. Farlow on specimens collected in Ontario by Mr. James Fletcher. It is probable, however, that its occurrence is general through the more northern States at least.

In speaking of this disease, as it occurs in Bermuda, Mr. Shipley states distinctly that "this fungus (*Macrosporium parasiticum*) is only found upon the onion after it has been attacked by the *Peronospora*" and it has usually been considered as a sequel to the *Peronospora*, rather than a specific disease in itself. Prof. Farlow in an appendix to the paper of Miyabe, just mentioned, states that no trace of the mildew was discoverable in the specimens of the *Macrosporium* sent him from Bermuda, which furnished the material for the latter's studies, and it was therefore a matter of some interest to ascertain to what extent, if at all, the *Macrosporium* was an independent disease in Connecticut.

That it is entirely independent of the *Peronospora* was easily shown from the fact that, although the latter fungus was observed only in the region about Wethersfield, the *Macrosporium* was found wherever the onion was cultivated. At Green's Farms and Southport, for example, a careful examination of numerous fields, both of seed and market onions, did not disclose a single instance of injury from the mildew, while the *Macrosporium* was everywhere abundant. That the two diseases are not necessarily associated can therefore be definitely stated; but whether the *Macrosporium* is in itself a primary cause of disease in onions, is another matter not so easily determined. That it usually follows an injury of some sort may be inferred

from its almost invariable association with the *Peronospora*, as well as with the injury produced by the onion Thrips, yet in several cases during the past season it was observed where no such previous injury was apparent.

A field of market sets at Green's Farms, for example, the sickly appearance of which was visible at some distance, was carefully examined early in July. The leaves were found to be covered with irregular whitish blotches and were withered and dried up at their tips. In the centre of these blotches and entirely covering the more withered portions of the leaf was found a coating of the *Macrosporium* associated with nothing else to which the injury could be attributed. A neighboring field of market onions was examined at the same time and found to be similarly, though not as severely, affected; and here also no indication was visible of previous injury by the Thrips, the *Peronospora* or any similar agency. The white blotches, when examined microscopically, showed a penetration by fungus hyphæ bearing the peculiar *Macrosporium* spores in the central portion of the spot. Isolated patches of the *Macrosporium* are also common on seed onion stalks generally, yet in such cases the entrance may have been effected through a bruise made in cultivating, or otherwise. It may be mentioned here that attempts to produce the disease by sowing spores upon healthy onion leaves were not successful.

Whatever the truth may be in this respect it is none the less certain that the fungus under consideration is seriously injurious whether it be primary or secondary. When it follows the *Peronospora*, especially upon seed onions, it extends the injury of the latter very greatly, breaking down stalks which would otherwise have kept erect and matured at least a portion of their seed, and causing the leaves to wither up entirely. In general it may be said that parts attacked by the *Macrosporium* appear to absorb and hold moisture very readily, so that the rotting away of such diseased portions is greatly hastened.

The injury of the *Macrosporium* is produced by a mass of slightly smoky branching hyphæ which penetrate to the deepest layers of cells, entering and destroying them. Certain of these hyphæ make their way to the surface, either through the breathing pores or directly through the cell walls of the epidermal layer, and in the air give rise to the oblong, dark brown spores represented in figs. 38, 39. These spores are covered with

numerous short projecting points and are divided by cross partitions into numerous cells ; that is they are compound, and when they germinate each of these cells may give rise to one or more hyphæ which, if favorably situated, grow into the onion plant and give rise to a new centre of infection. The studies of Miyabe have shown that this fungus is an imperfect stage of *Pleospora herbarum*. The latter fungus is characterized by the formation of nearly spherical bodies, known as *perithecia*, within which are produced numerous sac-like organs each containing eight brown compound spores, and was obtained directly from the *Macrosporium* spores. The fungus we are considering therefore, is merely a form of something else, and the name *Macrosporium* is retained to designate it only as a matter of convenience.

In regard to remedies in the case of this disease, it is not probable that any direct treatment would be advisable ; but it should be kept in check by the systematic destruction of all stalks and field refuse generally, which can only be done effectually by burning. Ploughing in such refuse, or composting it, should never be resorted to under any circumstances.

The Larger Onion Macrosporium (*Macrosporium Porri* Ell.).

PLATE III, FIGS. 40–43.

IN addition to the species of *Macrosporium* just described, a second fungus nearly allied to it, and resembling it closely in its effects, occurs commonly upon seed though less frequently on market onions. The spots which it produces are paler than those which characterize *M. parasiticum* ; usually more circumscribed and less inclined to inflict injury by the rotting and breaking of the seed stalk at the diseased point. It apparently does not, like *M. parasiticum*, commonly follow the onion *Peronospora*, and seems more truly parasitic in its habit than this fungus. Its dark, branching, septate hyphæ penetrate the tissues of its host in all directions, finally making their way to the surface and, just below the epidermis or within the epidermal cells or air spaces beneath the stomata, usually produce a compact sclerotioid mass of cells (Plate III, fig. 40*x*.) This body, which may consist of only a few or of a considerable number of cells, gives rise to one or several short hyphæ, bearing the large, solitary, brown, compound spores as represented in the figures. Nothing further concerning its

history can be given at present, and measures suggested for the destruction of *M. parasiticum* apply equally well in the present case.

Botanically the species is of some interest. It was first described by M. C. Cooke in Grevillea, vol. viii, p. 12, as *Macrosporium Porri* Ellis, from specimens collected on Leeks (*Allium porrum*) in New Jersey by Mr. J. B. Ellis. It was subsequently distributed in Ellis' North American Fungi, No. 370, on *Allium porrum* from New Jersey, under the name *Macrosporium Porri* Cooke & Ellis. In addition to various localities in Connecticut it has been collected during the past summer at Kittery, Maine, on market onions ; but beyond this nothing appears to be known of its distribution. A careful comparison of the Connecticut and Maine material of the fungus with the specimens distributed as above mentioned, and with others kindly sent by Mr. Ellis, leave no doubt as to the identity of the two. Mr. Cooke states in his description that "the large clavate spores are attenuated in the lower third of their length into a closely septate stem," a remark which indicates that they were not seen by him *in situ*, the attenuated base being in reality the apex as is shown in fig. 40, which was drawn from fresh material. The spores fall from their attachment with great readiness, yet the distinct scar at the point of attachment of the rounded base is always readily seen in detached spores. The species is therefore very possibly not a *Macrosporium* and approaches the genus *Alternaria*, although no indication was observed that the spores are ever formed in chains or consecutively from a single hypha, according to the peculiar manner of this genus. It may be mentioned that the spores vary very greatly in size and shape, as well as in the length of the attenuated end which, being usually the first point of germination, is often very greatly elongated. The spores of the form growing on seed onions differ, to some extent, from those found on the leaves, by their somewhat smaller size and greater regularity of shape. Their apex is usually more attenuated, the base evenly rounded, and in many cases there is an entire absence of any longitudinal partitions. These differences, however, do not appear to be greater than can be accounted for by the difference in the substratum.

The Onion Vermicularia (*Vermicularia circinans* Berk.).

PLATE III, FIGS. 44–46.

The outer bulb scales of the white varieties of onions, before they are harvested, are often attacked by a black growth, quite inconspicuous at this time, and composed usually of a central black dot, or small ring, outside of which one or more larger rings are arranged concentrically and with greater or less regularity. When kept in a moderately moist, warm atmosphere this black appearance extends itself with considerable rapidity, either growing in concentric circles or successive wavy lines, or forming evenly black areas on the bulb, as in fig. 44. At first this is confined to the outer layer of scales; but, as the disease extends, it penetrates several successive layers inducing decay and often presenting an appearance, beneath the outer layer, hardly distinguishable, at first sight, from the onion smut. If the black rings and blotches are examined closely they may be readily seen to be composed of numerous black points of various size, single or running together in clumps, and apparently made up for the most part of very minute bristles. A microscopic section of one of these points, shows that they are seated directly on the surface of the scale (fig. 45), the tissues of which are penetrated and disintegrated by numerous hyphæ, from which the black points themselves arise directly. The latter are composed of numerous long, black, pointed, bristle-like bodies growing directly from the hyphæ, and around the bases of which are clustered great numbers of short, colorless or slightly brownish bodies, the *basidia*, which also arise directly from the hyphæ and bear at their tips, the slender, slightly curved spores which propagate the fungus. These bodies are seen in fig. 46, which represents a very small bit of one of the black points separated and highly magnified. The spores are produced in very great numbers in a damp atmosphere, so that the black tufts become visibly whitened by them. When young, the black tufts are furnished with a sort of membrane which extends over the basidia at the base of the long bristles (fig. 45*x*); but finally disappears or remains only about the edges. Beyond this production of enormous numbers of minute spores nothing is known of its further development. In many cases, where the growth of the fungus was very luxuriant, it was found associated with large *sclerotia* which were somewhat flattened, jet black externally and white

within; but it cannot be definitely stated that these were connected with the fungus producing the black tufts, and at the present writing they have shown no further development.

The fungus under consideration appears to be a species first described by Berkeley in the Gardener's Chronicle (1851, p. 595) as *Vermicularia circinans* although it has not been possible to make any comparison of our form with authentic specimens of Berkeley's species. Since, however, it answers in all particulars to the meagre description transcribed in Saccardo's Sylloge, it is tolerably safe to assume that the determination is correct.

Its economic importance, which is very considerable, rests upon the fact that, although it does not as a rule injure the onions seriously, or become conspicuous upon them until after they are housed, it often attacks them subsequently to such an extent as greatly to disfigure them, and impair their value for marketing purposes. Some idea of the serious nature of the disease may be inferred from the fact that one gentleman, whose statement is wholly reliable, estimates his actual loss from this cause during the past season at several thousand dollars.

The fungus is introduced into the onion house from the field, where it occurs not very abundantly on the bulbs before they are pulled, especially if they have been weakened from any cause, and among the housed onions it propagates itself with a severity proportional to the favorableness of the conditions offered it for the formation, dissemination and germination of its spores above described. These conditions are warmth and moisture, and the proximity of uninfected bulbs. It may be communicated by contact with diseased bulbs or with any object, such as the hands, or tools that have been subjected to such contact, and may be also spread by strong drafts which blow about the spores or dry scales containing them.

The most important precaution which can be taken against the disease, consists in housing the onions during dry weather after the bulbs are thoroughly dried off. No bins which have contained such black onions should be used a second time, until they have been thoroughly cleaned and sprinkled with quick lime, or quick lime and sulphur. All danger of heating should be avoided, and the onions stored in as cool and dry a place as possible, which can be arranged to be ventilated in dry weather and shut up when the atmosphere is moist. Should the fungus be noticed on the bulbs at the time of storing, or in any case

when there has been previous damage from this cause, it is probable that a treatment with dry air-slaked lime, such as has been recommended with success for potatoes (one bushel of lime to twenty-five bushels of onions), applied *at the time of storing*, would prove of great service in checking the spread of the fungus. The utility of this practice, however, needs confirmation by actual experiment before it can be definitely recommended. In any case, such treatment should be made at the outset, since it would have comparatively little influence after the disease was well established.

The question has been asked whether bulbs attacked by the *Vermicularia* can safely be used for seed onions, and it may be said that this can be done with perfect safety, provided that the fungus has not attacked them sufficiently to have induced rotting; since as a rule the surface layers only are affected, the bulb being otherwise sound. No infection of the seed or seed stalk is to be feared; but the old bulbs will be likely to harbor the fungus during the summer, and communicate it to market onions if planted near them.

Note on some other Diseases of Onions due to Fungi.

Although the five fungus diseases above described are the most important ones which were observed to affect the onion in Connecticut, there are numerous other fungi which are known to be injurious to this vegetable, and its near relations belonging to the same genus *Allium*. One disease which may be noticed as occurring in this State is the common "white blast" almost always met with among seed onions. It is a disease unconnected with the *Peronospora* above described, which attacks seed onion stalks, causing them to turn white and often flaccid, and only appearing here and there in the rows. It is commonly attributed to the work of the onion fly ("maggot"), but in the majority of cases the bulbs at the base of such stalks are perfectly sound. Microscopic examination usually shows the presence of numerous hyphæ on the inner side, belonging to a species of *Mucor*, accompanied by great quantities of Bacteria which collect in yellow masses. Whether either of these forms are directly connected with the "blast" cannot at present be stated.

Another fungus which did great injury to onion seedlings in the hot-house may also be mentioned. Plants attacked by this

disease became white and flaccid near the base, soon falling over and withering. The cause in this case was a fungus related to the moulds (*Saprolegnia*) often destructive to fishes; and belonged to the genus *Pythium*. Whether the species is identical with *P. DeBaryanum*, also said to produce disease among various seedlings, was not determined.

No other fungi which seemed truly parasitic, were observed on cultivated onions, during the past season, although saprophytic forms were not infrequent; but in order to give some idea of the number of diseases due to fungi which are liable to occur on onions generally, both wild and cultivated, the following list of names is appended, for several of which thanks are due Prof. Seymour of Cambridge. The list is doubtless incomplete; but is nevertheless sufficiently long to serve the purpose in view.

List of Fungi Parasitic upon Members of the Genus Allium.

NAME OF FUNGUS.	NAME OF HOST.
Æcidium alliicolum Wint.,	Allium stellatum.
" Convallariæ Schm.,	" reticulatum.
" reticulatum Thm.,	" victoriale.
Acrothecium melanopus (Sz.) Sacc.,	" cepa.
Cæoma (Uredo) Alliorum Lk.,	" cepa, porrum, etc.
Cercospora Victorialis Thm.,	Allium victoriale.
Cladosporium sparsum Sz.,	" cepa.
" fasciculare (Pers) Fr.,	" sp.
Darluca aschochytoides Sacc. & Roum.,	" ampeloprasum.
Fusariella atrovirens (Berk.) Sacc.,	" sps.
Heterosporium Allii E. & M.,	" vineale.
" " var. Allii-porri, Sacc. & Br.,	" porrum.
" Ornithogali Klotsch.,	" vineale?
Macrosporium cladosporioides Desm.,	" sp.
" Porri Ellis,	" porrum.
" punctatum Kalch. & Cke.,	" schœnoprasum.
" vescicarium (Wallr.) Sacc.	" sativum.
Mucor subtilissimus Berk.,	" cepa.
Mystrosporium Alliorum Berk..	" sp.
Perisporium exuberans Fr.,	" sp.
Peronospora Schleideni Ung.,	" cepa, etc.
Phoma alliicola Sacc. & Roum.,	" sp.
Phyllachora Cepæ (Sz.) Sacc.,	" cepa.
" penicillata (Sz.) Sacc.,	" sp.
Pleospora Allii (Rabh.) Ces. & DeNot.,	" cepa, porrum.
" Cepæ (Preuss.) Sacc.,	" cepa.
" socialis Niessl. & Kunz.,	" cepa.
Puccinia Allii (DeC.) Rud.,	" sativum, etc.

Name of fungus.	Name of host.
Puccinia mutabilis Ell. & Gall.,	" mutabilis.
" Porri (Low) Wint.,	" cepa, porrum, fistulosum.
" sessilis Schn.,	" ursinum.
Rhizoctonia Allii Grev.,	" ascalonicum.
Saccharomyces Allii Sor.,	" cepa.
(Sclerotium cepivorum Berk.),	" cepa.
Scolecotrichum diplodioides (Thm.) Sacc.,	" neapolitanum.
Septoria alliacea Cke.,	" sp.
" alliicola Baum.,	" flavum.
" Alliorum West,	" porrum, etc.
" viriditingens Curt.,	" tricoccum.
Sphærella allicina (Fr.) Auers.,	" sp.
" Schoenoprasi Auers.,	" porrum, etc.
Torula Allii (Harz) Sacc.,	" cepa.
Urocystis Cepulæ Frost,	" cepa.
" Colchici (Schl.) Rabh.,	" sps.
" magica Pass.,	" magicum.
Uromyces aculeatus Fckl.,	" victorialis, etc.
" ambiguus (DeC.) Fckl.,	" scorodoprasum.
" Erythronii (DeC.) Pass.,	" victorialis, etc.
" vernalis Speg.,	" striatellum.
Vermicularia circinans Berk.,	" cepa.
" dematium (Pers.) Fr.,	" cepa.
" Liliacearum S.,	" sp.
" Schoenoprasi Auers. & Fckl.,	" schœnoprasum.

Mildew of Lima Beans (*Phytophthora Phaseoli* Thaxter).*

Plate III, figs. 29–37.

The Lima bean (*Phaseolus lunatus*) is, as a rule in this climate, vigorous in its growth and little troubled by fungus enemies. A fungus has, however, appeared in New Haven and vicinity within a radius of at least fifteen or twenty miles, which bids fair to become the most serious obstacle yet encountered in the cultivation of this vegetable. The disease first shows itself as a spot, having a white, woolly appearance, usually on one side of the unripe pods. This spot extends rapidly during damp weather, penetrating, and appearing on both sides of the pod, which it often covers completely with a clear, white, thick, woolly coating. At the same time the pod begins to decay and usually ends by becoming shrivelled and black. As in the case of the onion *Peronospora*, a nearly related disease, the black

* *Botanical Gazette*, vol. xiv, p. 273, Nov., 1889. Specimens are distributed in Seymour and Earle's "Economic Fungi," No. 9.

appearance which follows the mildew is not directly connected with it, but is due to the growth of several other fungi, *Cladosporium*, *Macrosporium*, *Epicoccum* and other common forms, which complete the destruction begun by the mildew. Notwithstanding the fact, however, that these common fungi have really no connection with the disease in question, they are more likely to attract notice than the mildew itself, and the dry blackened pods hanging in all directions in a diseased piece are the most noticeable feature in connection with it. The mildew does not confine itself to the pods by any means, though most conspicuous upon them; but attacks the young shoots as well, distorting them and stopping their growth, and also, though less commonly, the leaves, involving the larger veins as well as the petioles.

At Hamden, near New Haven, where it was first noticed early in September, the disease has appeared with great severity, destroying, in some cases, a very large percentage of the crop. It is said to have been known as injurious in this region for about two years; but never as much so as during the past season. It was not seen on any other than the Lima beans, nor has it been observed on the wild bean (*Phaseolus diversifolius*) common about New Haven, or on other plants belonging to the family of *Leguminosæ*. Its origin, therefore, is purely a matter of conjecture, since, although it seems scarcely probable that so conspicuous a form should have been overlooked in so thoroughly explored a region as the New England and adjacent states, it has been equally overlooked in other parts of the world, if indeed it is a foreign importation.

Examination of a section of the diseased tissue shows it to be penetrated by the irregular branching hyphæ of the fungus, which run between the cells and, collecting in the air spaces beneath the breathing pores, push out through them into the air (fig. 30) in such numbers that the latter are completely obliterated. These hyphæ (fig. 39), just at their point of exit from the breathing pores, are usually slightly swollen and give rise to one or more branches which grow almost vertically into the air, and, taken together, produce the white woolly appearance already mentioned as characteristic of the disease. These vertical branches may themselves be once dichotomously branched, that is give rise to two branches, forming a more or less symmetrical fork; while at their tips they swell out into the large, terminal, oval conidial spores represented in the figure. A pecu-

liarity of the genus *Phytophthora*, of which this fungus constitutes only the third form known, consists in the fact that after a spore has been produced at the apex of a hypha, the hypha continues to grow at the point where the spore is attached, pushing it to one side if it has not already fallen off, and soon swelling into another spore. This may be repeated several times, the points where spores have been previously formed, being marked by successive vesicular swellings (fig. 29 *x x*). The spores, when mature, are blown by the wind or fall upon different portions of the bean vine or adhere to other objects, and under proper conditions of moisture germinate. The germination takes place in two ways. In the one case a single hypha of germination is produced, which may enter the host plant directly or give rise to another, or secondary spore like itself (figs. 31-32) which germinates in its turn like the ordinary conidia. In the second case, which is by far the most common, the contents of the spore becomes very faintly lobular, as shown in fig. 33, and suddenly and rapidly begins to make its exit, through the ruptured apex of the spore, in the form of a continuous chain of spindle-shaped bodies, consisting of naked protoplasm; the orifice alternately expanding and contracting as each body is, as it were, squeezed out by the pressure from within. In some cases the whole contents of the spore makes its exit thus, the chain winding itself into a round or oval mass above the apex of the conidium as in fig. 35. Usually, however, the chain breaks in the course of its discharge and almost instantly a rapid motion begins, at the point of separation, which draws the spindle-shaped bodies successively apart. The motion is due to a slender thread or cilium, drawn out by the pulling apart of the narrow zone connecting two adjacent bodies, and the rapid vibration of this thread gives rise to the motion just mentioned. The spindle-shaped bodies, as soon as they are free, move irregularly for a moment, changing their shape the while, till they become contracted, the two extremities being drawn together on one side towards a small clear spot, usually present in bodies of this nature, so that in one view the outline is slightly crescent or bean-shaped (fig. 36). After or during this change of shape the motion of the cilia becomes very rapid, and the bodies, which are known as *zoöspores*, dart away in the surrounding water. After swarming for a certain time, usually about half an hour, the zoöspores come to rest, assume a spherical shape, swell considerably, become surrounded by a thin cell wall

and very soon begin to germinate (fig. 37) by giving rise to a hypha which makes its way into the tissues of the host plant, thus infecting it with the disease. This whole process, owing to the minute size of the zoöspores which are less than $\frac{3}{10000}$ of an inch in diameter, may take place upon the moist surface of a leaf or other portion of the host plant, the thinnest pellicle of water being sufficiently deep for them to swim in. The usual number of zoöspores formed from spores of average size is about fifteen, so that each spore may give rise to fifteen distinct points of infection.

The discovery of this species is of some little interest botanically since, as has been mentioned, it is only the third representative at present known of the rather peculiar genus to which it belongs. The fact that one of the three is the much dreaded potato blight (*Phytophthora infestans*), the life history of which is therefore similar, is sufficient indication of how serious a disease it may become should it spread among truck gardens generally.

The third species of the genus, *Phytophthora Cactorum*, is not known to occur as yet in this country; but is destructive in Europe, where it is found on many Coniferæ, as well as upon Cactus of several varieties, Sempervivum and various other plants, not to mention decayed animal substances on which it grows as a saprophyte. It was first named *Peronospora Cactorum* by Cohn and Lebert, being subsequently described on Beech seedlings by Hartig as *P. Fagi*, and at the same time by Schenk on Sempervivum as *P. Sempervivi*. Finally all three were united under the name *Phytophthora omnivora* by DeBary who demonstrated their identity by artificial cultivation: yet there seems no necessity for rejecting the earliest name. The *Phytophthora* of Lima beans resembles *P. cactorum* in the large size of its spores, which, however, are smaller than those of the last named species and much less variable, rarely attaining a length of 50^{mm}. Its hyphæ also are very rarely if ever septate, as in *P. Cactorum*, while it differs entirely in the branching of its conidiophores (fig. 29) as well as in numerous other points of structure or development. Although resting spores frequently occur in *P. Cactorum* they are not certainly known in the potato fungus, and were not observed in connection with the mildew of beans, although their existence must be inferred from the fact that the hibernation of the fungus in this case seems hardly explicable on any other supposition.

Before considering remedies for this disease it will be necessary to make further observations upon it in order to ascertain the date and manner of its first appearance. It may be said, however, that the destruction of all vines and refuse in the field by burning them as soon as picking is finished, cannot be too strongly urged; since the winter stage of the fungus must exist in them, whatever it may be, and will otherwise propagate the disease another year. Composting the vines or using them for fodder or bedding, as is often done, should never be resorted to; since the resting spores would be spread with the manure thus obtained. Hand picking of the diseased pods or shoots, as soon as the white mildew shows itself, should certainly check the spread of the disease; but to be effective this should be done early in the season when it first appears, probably about the middle of July.

It is hoped that more knowledge of this interesting fungus may be gained during the coming season, and any information concerning its prevalence, distribution, etc., will be greatly appreciated if communicated to this Station.

Miscellaneous Notes.

The following notes on the occurrence of a few of the many fungus diseases prevalent during the past season may be of some interest.

Helminthosporium inconspicuum C. & Ell. White blast of Indian corn. This disease was widely injurious during August and September, blighting the leaves and hindering the proper ripening of the ears. Fields affected by it look as if they had been visited by early frost. No other stage of the fungus is known and no remedies or precautions can be suggested, beyond burning affected material as far as possible, and avoiding the use of barn manure on corn fields, or fields adjacent, when such manure is derived from stock to which diseased stalks have been fed.

Ustilago Maydis (D.C.) Smut of Indian corn. This disease has been remarkable for its absence during the past season, although unusually abundant in 1888.

Monilia fructigena Pers. "Rot" of Peaches, Cherries, Plums, etc. Forming grayish pustules over the fruit which may ultimately become wholly covered by a wrinkled, powdery coating, consisting almost wholly of spores. The fungus attacks the

ripe or unripe fruit before or after it is picked, and has been very destructive, to plums and peaches especially, spreading from one to another while yet hanging on the tree. Perfectly sound fruit is readily infected with it, but more commonly that which is bruised or punctured. The leaves and tender shoots are also subject to the disease. No treatment can be recommended for this fungus on the fruit, since fungicides fail to adhere sufficiently to green plums; and peaches, when attacked on the tree, are usually so mature that they would be injured by any application. All fruit, however, should be picked off and burned, or buried several feet below the ground, as soon as a spot of the disease appears upon it; for the fungus is sure to spread from this to the sound fruit. Fruit should never be left to rot under the trees, where it is certain to breed the fungus. For this reason peaches, etc., picked green to thin out an excessive yield, should never be left on the ground, but should be buried at once.

Glœosporium necator E. & E. Anthracnose of Raspberry. Produces numerous round or elongate whitish patches on the "canes," and small yellowish spots on the leaves. It is locally very destructive, ruining the new growth or stunting it badly. Two plants very much diseased, sent by Mr. H. L. Jeffrey from New Milford, were set out in the greenhouse in February in order to see if the fungus hyphæ were perennial in the old tissues and would extend from them into the new growth. The canes themselves were kept dry to avoid any fresh formation of spores from the old spots. Fresh shoots, developed from below the ground as well as from the old canes above and below the diseased spots, showed no signs of the fungus, indicating that its destruction would be complete if all diseased wood were cut in winter, below the lowest spot of *Glœosporium*, and *burned*. Spots of the previous year, as was personally observed, give rise in May to a fresh production of spores, which convey the disease to the new canes and foliage. Burning of all diseased canes in autumn or winter is of the first importance, and care should be taken to avoid keeping the raspberries too thick, in order to insure free ventilation. Treatment with fungicides would doubtless check the spread of the disease if used in season.

Caeoma nitens Schw. Blackberry rust. This is everywhere destructive among wild and cultivated varieties of raspberries and blackberries, first showing its presence by the yellow look of the stems and foliage of the new shoots, and by their usually

fascicled, wiry growth; finally appearing on the under side of the leaves as a very brilliant orange powdery coating. The fungus is perennial in the tissues of the host and is therefore incurable. Diseased plants should at once be dug up and burned as soon as they show signs of the disease, and before the orange powder appears on the under side of the leaves.

Cladosporium fulvum Cke. Forming rusty brown patches on the under side of tomato leaves, blighting the foliage in August and September, has been somewhat destructive, but is not very injurious as a rule. Should it become so it would be easily controlled by fungicides.

Phytophthora infestans (Mont.) Potato rot and blight destroyed nearly all the potato vines in the State and appeared on tomatoes in September. It can undoubtedly be controlled, in ordinary seasons, by the use of Bordeaux mixture or other fungicides. It appeared very early this year (July 7), but usually is not destructive until late in July. Treatment should be applied as soon as a single leaf is seen to be affected, and if the field has been blighted the year before, the application had best be made early in July, and may be combined with Paris green for potato bugs, as has been shown by several experimenters. (See also p. 174.)

Cercosporella Persica Sacc. Appearing in patches on the under side of peach leaves as a clear white, somewhat powdery coating, and causing the premature defoliation of the tree, was injurious in the Valley Orchard Co.'s peach orchard at Deep River. Although the trees ripened large, fair fruit, its flavor was inferior, and the early defoliation doubtless injured the maturing of the new wood and buds. No remedy can be recommended at present.

"*Fusicladium*" *pyrinum* (Lib.) one variety of pear "scab" forming dark olive patches on the leaves, usually on the under side, as well as on young fruit, which it distorts or kills, has been locally very injurious. It bears some resemblance to the scab of apples (*Fusicladium dendriticum*), but is a quite different fungus. It appears very early in the season and should be controlled by fungicides, if properly applied.

Entomosporium maculatum Lev. the "spot" of quinces, causing brownish discolorations on the leaves which fall prematurely, and unsightly patches on the fruit, has been injurious almost everywhere. The same fungus occurs more rarely, in this State

at least, on pear leaves and fruit. Experiments have shown that it is readily controlled by fungicides.

Sphaerella Fragariae (Tul), Strawberry blight, has been unusually injurious, being the apparent cause of the partial or almost total failure of the crop in many sections. On the leaves it appears as a reddish spot or patch with a whitish centre, but it causes even greater injury on the fruit stems and hulls, cutting off the supply of nourishment from the berries and disfiguring them by the withering of the calyx lobes. The disease has been successfully treated with fungicides.

Sphaceloma ampelinum DeB., Anthracnose of grapes is, so far as observed, the most generally destructive disease of grapes in the State. It appears upon the leaves and young shoots, stunting them or stopping their growth entirely, and also affects the berries. It is often popularly mistaken for black rot, a quite different fungus. No very effective remedies have as yet been recommended beyond close trimming below all spots of disease, and the burning of all diseased wood or leaves, as far as possible. Spraying the vines with a 25 per cent. solution of sulphate of iron before they begin to start in the spring, and the subsequent application of equal parts of lime and flowers of sulphur as a powder to the fruit and foliage, at intervals during the growing season, has been recommended.

Puccinia coronata and *P. graminis* have been injurious, especially to oats, the first named rust being most destructive. The most widespread "rust" of oats about New Haven has, however, been due not to a fungus, but to an insect, the oat Thrips (see p. 180).

Uromyces striatus Schröt. A rust, apparently this species, has been locally destructive to clover rowen in August and September, the chestnut brown spots of Uredo spores being very conspicuous on the under side of the leaves; the winter or teleutospores, occurring mostly on the stems or petioles.

Experiments with Bordeaux Mixture.

Through the kindness of A. J. Coe, Esq., of Meriden, a test was made of the Bordeaux mixture on his vineyard, rather with a view of getting some practical knowledge of the application of fungicides than for the purpose of making an elaborate experiment. The vineyard in question contains about two acres of Concord grapes, the rows running north and south, and for

several years past the crop has been an almost total failure from black rot. The past season could hardly have been a more unfavorable one for the purpose of experimenting, rain having fallen on an average every other day during the last half of May and the whole of June, and more than every other day, on an average, through July and the first week of August. The weather was, therefore, not only as favorable as possible for the growth and spread of the fungus; but was also equally unfavorable for the successful application of fungicides, the latter being washed off more or less, almost as soon as they were applied. The mixture used was of the strength usually recommended, viz: 6 lbs. sulphate copper, 6 lbs. quick lime, 22 gallons water, and as the rows were on sufficiently level ground, the spraying was done by driving a team between them, carrying the mixture in a cask on which was mounted a force pump, with a coupling on either side connected with light hose furnished with Vermorel nozzles. With a man to pump and keep the mixture stirred, and a man at each hose, with a boy to drive, the application was made very rapidly, one side of two rows being done simultaneously. Five rows in the center of the vineyard were left untreated, and the east half, which in previous years had been the worst affected, received tolerably thorough applications; while owing to circumstances the west half had to be somewhat neglected. On the east half applications were made May 17th, when the vines were just beginning to make their first growth. The vines were sprayed again June 7th after the grapes had set, and again on the 13th and 28th of June, the 16th of July and the 3d of August. The fungus began to appear early in July, only upon the berries, and even as late as July 13th but a small percentage of the clusters on the untreated rows were attacked. When the vineyard was next seen July 29th, there was not a single cluster and very few berries still green in the untreated rows. The rot had extended from the untreated rows to the neighboring treated rows, those nearest being more generally affected: about 75 per cent., however, of the treated clusters were free from disease. When the grapes were picked Sept. 23d, the untreated rows had proved a total failure, not maturing a single cluster, while the treated rows yielded from 60 to 75 per cent. in good condition. At this date the mixture adhered to many of the clusters and was brushed off with a soft brush as they were picked, without great difficulty. The foliage was well re-

tained in the untreated rows and wholly so in the treated rows, in fact there was not at any time much indication of disease in the leaves.

Mr. Coe also applied the Bordeaux mixture to two large trees of Lombard plums, leaving a third untreated. The trees always set an abundance of fruit which was wholly destroyed by the fruit Monilia (*Monilia fructigena*), and in addition to this disease were subject to black knot (*Plowrightia morbosa*), and to defoliation by the plum leaf fungus (*Septoria cerasina*). As a result of three very thorough applications made May 22d, June 14th, and July 16th, the two treated trees held their foliage intact up to severe frost in October, showed hardly any black knot and matured a fair amount of fruit; while the untreated tree was defoliated in August, matured no fruit, and was badly infested by the black knot. An experiment on so small a scale must be taken for not more than it is worth, yet the differences between the treated and untreated trees can hardly be explained as due to causes other than the application of Bordeaux mixture. The mixture did not adhere to the plums to any extent, which may account for the fact that the Monilia was not more effectively controlled. Hand picking of all diseased or spotted plums should have been resorted to early in the season.

An application of the Bordeaux mixture to test its effect on the potato blight (*Phytophthora infestans*) was also made on the Webb farm at Hamden. For this purpose a rectangular piece 50x150 feet was selected in the corner of a large field, and treated with a mixture containing 10 lbs. sulphate of copper, 10 lbs. lime and 30 gallons of water. The application was first made July 18th, when about one per cent. of the foliage of the field was already attacked by blight. On the following day it rained, with fog, and at night rained very heavily. This was followed by three days of fairly clear weather, but the next day (July 23d) brought more fog and a heavy thunder shower. Notwithstanding this, the mixture held fairly well, and when the vines were treated again July 25th, from 80 to 100 per cent. of the foliage in the untreated portion of the field was destroyed by blight, while not more than 5 to 10 per cent. in the treated piece was injured. One day of clear weather followed this second application, but heavy rains fell on the two succeeding days followed by one day of hot foggy weather. July 30th rain fell

in torrents, and heavy rains and fog continued every day till Aug. 3d, when another application was made. At this date the treated piece retained from 50 to 60 per cent. of its foliage, while the rest of the field was quite black, without a vestige of a green leaf. On the same day after treatment, rain and fog continued, clearing Aug. 4th, but raining again Aug. 5th. Then followed three clear days, then a warm rain Aug. 9th and 10th. On Aug. 10th, the piece was examined for the last time and was found still to retain about 25 per cent. of its foliage.

The result of the application as far as concerns the protection of the foliage must be considered very successful, when the weather which prevailed during the experiment is taken into consideration. But the comparative weight as reported by those in charge of the harvesting and weighing of the whole field (which was for the most part a field experiment conducted by the Station), showed a slight proportional difference in weight *against* the treated piece. The rows were examined personally just after they had been ploughed, however, and the number and size of the potatoes thus exposed was in several of the rows distinctly in favor of the treated plot, as could be seen by comparing the yield at the points where the treated and untreated portion of the rows met. It seems therefore probable that the unfavorable showing may have been due to some error either of those who harvested or weighed the crop. It certainly would seem very singular if the preservation of the foliage accomplished, should have been an injury to the crop, and it should be mentioned here that experiments of a similar nature tried elsewhere during the past season, have given a result very greatly in favor of the treatment, both as regards the bulk and keeping qualities of the crop.

Farmers are strongly advised to try experiments for themselves with the use of fungicides, for which full directions will be furnished by the Station on application, adapted to the particular disease which it is desired to treat, and when possible, personal supervision will be given if requested. Such coöperation on the part of farmers is much to be desired from the fact that no farm is attached to the Station, and experiments of this nature cannot otherwise be made. A bulletin on the subject of the preparation and application of fungicides will be issued shortly.

NOTES IN ANSWER TO INQUIRIES CONCERNING INJURIOUS INSECTS.*

Mamestra picta Harris.—A box containing a number of the caterpillars of this moth was received from Saybrook, where they were said to have been found injuring onions. The species is common in New England and elsewhere, the moth, of a dull red color with white underwings, being double brooded, appearing in May and July. The larvæ, which are conspicuously marked with black and yellow lines and spots, are at first gregarious; feeding in swarms on all sorts of garden vegetables, as well as many weeds; but separate as they mature. Although they eat the leaves of such a variety of plants, the onion does not commonly attract them, and no danger to this crop from them is to be feared. When they are injurious, and Paris green can be used with safety, it would doubtless prove entirely effectual against them.

From the same locality the larvæ of the following moths were also received for determination.

Telea Polyphemus Cram.—The American silk worm, a stout, large, green larva with two rows of pearly tubercles along the back, feeds on a great variety of trees, oak, birch, elm, maple and willow perhaps most commonly; but rarely if ever, in New England at least, is noticeably injurious. The larva spins a stout cocoon of coarse silk from which the large moth, buff colored with conspicuous blue and black eyes on the under wings, emerges in May and June.

Citheronia regalis Fabr.—The "Indian Chief" caterpillar, a large dark green larva with four pointed and curved red horns on the back behind the head, feeds upon hickory and walnut and is never common enough to be injurious. It changes to a chrysalis in the ground, sometimes spinning a thin cocoon under fallen wood, etc., and in June and July of the following year hatches into a large handsome moth marked with orange red, and yellow.

Phlegethontius Carolina Linn.—The "tobacco worm," injurious also to potatoes and tomatoes, is familiar to every one, and has

* The Station will gladly answer inquiries concerning injurious insects, which should be accompanied in all cases by specimens of the insect and its food plant, packed in a stout box for mailing. Such inquiries should be addressed to the Conn. Agric. Exp. Station, New Haven, Conn.

been unusually injurious to tomatoes during the past season. The brown hawk moth which it produces, with round orange yellow spots along the sides of its body, hatches from the subterranean chrysalis in June and July. Both this and the "tomato worm" (*P. Celeus* Hubn.) are so large and conspicuous that they can be readily picked by hand. The latter species is comparatively rare in southern Connecticut: but replaces *P. Carolina* almost entirely further north.

Cœlodasys unicornis A. & S.—A number of brown hunch-backed larvæ with a green patch behind the head, received from Lakeville, proved to be this species, and were said to have been found on plum trees. The larvæ, beyond their odd shape, are peculiar for a biting, volatile acid which they secrete when handled, irritating when inhaled; but not poisonous, and common to all larvæ of the same genus and its allies (*Oedemasia, Ianassa*, etc.) The present species feeds on numerous plants, especially those belonging to the rose family (Rosaceæ); but, although common, is rarely injurious. The inconspicuous greenish gray moth is double brooded, the larvæ of the second brood hibernating in a brittle cocoon, changing to a chrysalis and then a moth in May and June.

Ecpantheria scribonia Stoll.—A large, black, hairy caterpillar, red between the segments, was received from West Haven. It spun a slight cocoon in the autumn and hatched during the winter in a warm room. The large, stout bodied, white moth, marked with irregular black rings, is rare in New England; but common in the Southern States, where, however, it does not appear to be injurious.

Crioceris Asparagi Linn.—Several complaints have been received of the depredations of the asparagus beetle which in some localities, has completely stripped the asparagus of its foliage. The brightly colored beetle hibernates, like the potato beetle, coming out in the spring to lay its eggs on the young market shoots. The eggs hatch into a dark blackish-brown larva which feeds on the asparagus till it is mature, changing to a chrysalis, and then to the beetle again, which lays another batch of eggs, so that several successive broods follow each other through the summer; the last brood of beetles hibernating as above mentioned.

It is a well known European pest, and was introduced into this country about 1859; appearing about New York, where it eventually became very destructive, extending into the neighboring states. To obviate their injury all volunteer growth, as well as the seedlings between the rows, should be destroyed, so that the beetles will be forced to lay their eggs upon the market shoots which can be cut and sold before the latter hatch. When cutting has been discontinued entirely, Paris green applied in the usual way several times during the season will destroy the larvæ effectually.

Coleothrips 3-fasciata Fitch.—A "rust" of oats has been the cause of much complaint throughout the State during the past summer, and where examined proved to be due, in most cases, not to the common fungus rusts (*Puccinia coronata* and *P. graminis*); but to a minute insect which Mr. Pergande of Washington has kindly determined as probably *Coleothrips 3-fasciata* Fitch. Fields infested by it have a reddish, wilted look and often mature comparatively little of their seed. No remedy can be suggested in this case.

Thrips, n. s.—The 'white blast' of market onions is the most serious disease to which onions in the field have been subject this year, and has been reported from numerous localities and observed in all the onion districts which have been visited. The injury gives the field a white appearance which starts in one or more spots and spreads in all directions. The onions themselves are stunted in their growth, the leaves dying more or less completely according to the severity of the attack, becoming water soaked at the base if the weather is at all wet, inducing decay and generally injuring the keeping quality of the bulbs. The insect which produces this result has been determined by Mr. Pergande as an undescribed species of *Thrips*, an insect allied to that producing the rust of oats above mentioned. A similar insect, very probably the same species, is described by Mr. Shipley (Kew Gardens Bulletin of Miscellaneous Information, No. 10, 1887, p. 18) in his studies of the onion diseases in Bermuda, but was not injurious to any extent according to his statement. Should it become so he suggests a treatment with sulphate of iron; but it seems probable that ordinary kerosene emulsion would be very effectual against this insect, which, from its habit of congregating in the angles between the leaves, would be readily and effectually reached by the solution, a trial of which is strongly recommended.

LABORATORY APPARATUS.

Here follows an account of several pieces of apparatus devised at this Station and proved by lengthened experience to be satisfactory. They represent a part of the work of the Station, and it is believed that full descriptions of them will be helpful to others engaged in agricultural investigation. This paper is accordingly technical in its character and is prepared especially for the use of agricultural chemists.

Hydrogen Generator.

A full supply of some inert gas is necessary in agricultural chemical laboratories for making moisture determinations with accuracy. Hydrogen by reason of its rapidity of diffusion and the ease of obtaining it in a state of comparative purity has decided advantages over any other gas. The ordinary Kipp generator and other portable apparatus do not supply enough gas nor sufficient pressure for this use.

The accompanying figures 1, 2 and 3 represent an apparatus made by Prof. S. W. Johnson and Dr. T. B. Osborne which has been in use for about three years at this Station with most satisfactory results. The principle of its construction is the same as of the Kipp generator. The three vessels *A*, *B* and *C*, Fig. 1, are of stone ware and were bought of Messrs. Eimer & Amend of New York. *A* is No. 8456 of their catalogue, "Woulff's Bottle of best German acid-proof stone ware," capacity 8 gallons. *B* is No. 5954*a*, "Chlorine apparatus of acid-proof stone ware, with ground air tight cover," capacity 20 gallons, and the perforated inside vessel, *C* is No. 5954*b*. *B* should be ordered with "outlet near the bottom and ground-in stop cock." The stone ware basket *C* within *B* is perforated with many $\frac{1}{2}$ inch holes. In the bottom of *C* is placed a layer of coarse quartz gravel four or five inches deep. On this are laid 100 pounds of zinc spelter—broken ingots—as shown in the figure. The acid-reservoir *A* stands on a bracket shelf covered with sheet lead, directly above *B* so that any leakage may fall into the sink *M* below. The three necks of *A* are closed with rubber stoppers, the central one provided with a glycerine valve, seen in the figure, which admits air and hinders the escape of acid fumes. The pressure of gas is regulated by the height of the reservoir *A*. In our arrangement, a

Fig.1.

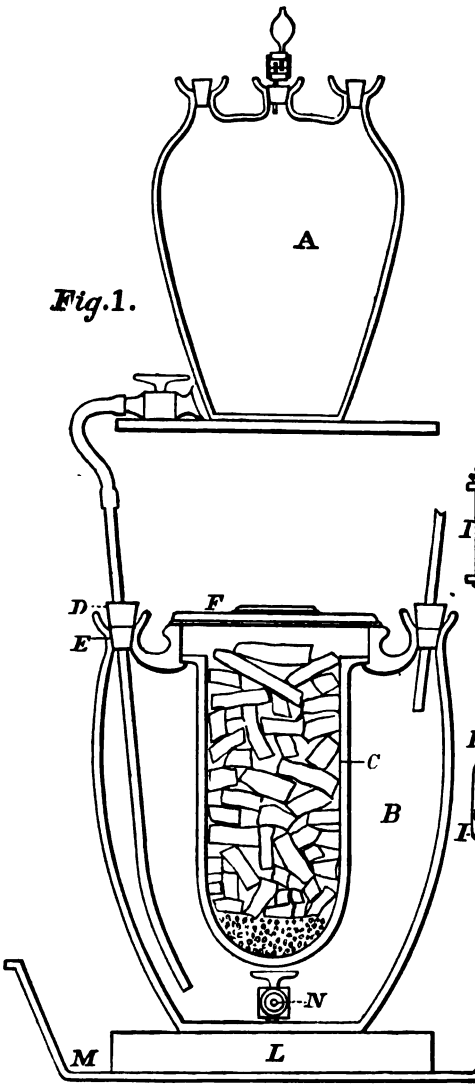


Fig. 2.

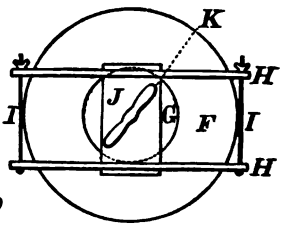
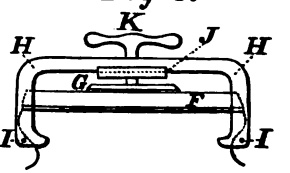


Fig. 3.



distance of only 3¼ feet between the bottoms of *A* and *B* was available and this has proved sufficient. *A* is connected with *B* by a stout glass tube one inch in diameter, which goes nearly to the bottom of *B*. It is joined to the stop cock of *A* by a tight-fitting piece of rubber hose which has been thoroughly soaked in a mixture of melted paraffine and vaseline. To enter *B* this tube passes loosely through a wooden collar, *D*, about 3 inches long and tightly through a rubber stopper, *E*, which is driven well down into the tubulure. The collar and stopper are securely tied down by stout copper wire to the neck of the tubulure. This fastening is not shown in the figure. The cup-shaped cavity above the stopper is finally filled with a melted mixture of paraffine and vaseline [having when cold the consistency of soft lard] so as to completely cover the rubber. The leaden exit tube of ½ inch bore for the hydrogen gas shown on the opposite side of *B* is similarly secured. It is carried some 20 feet to a table in the laboratory on the floor above, where it is provided with a very carefully ground brass stop cock. In this way perfectly gas-tight joints capable of resisting the pressure of the apparatus are obtained without difficulty. The cover of *B*, see sectional drawings, Figs. 2 and 3, is made of cast iron ¾ inch thick in order to sustain the strain of the heavy clamps required to hold it in place. The earthen ware cover furnished with the jar was found to be too weak. Beneath the cover *F* which is planed to a true surface is a thick sheet of soft vulcanized rubber thoroughly impregnated with the melted paraffine-vaseline mixture. Above *F* is an iron disc *G* about six inches in diameter, separated from *F* by a rubber disc to equalize pressure. Two steel clamps *H H* tied together by iron screw-bolts, *I I* to keep them in position, rest on a wrought iron plate ½ inch thick *J* whose ends are turned up as indicated in Fig. 3. Through the center of *J* passes the screw *K* ½ inch thick with a transverse handle. The end of the screw bears upon the disc *G*. The ends of the clamps embrace the stout flange about the mouth of the stone-ware vessel and are well fitted to its contour.

The sheet rubber beneath the cover *F* serves not only to pack the joint but also to protect the iron from corrosion by the acid in the vessel beneath. The vessel *B* rests on a large fire brick *L* soaked in melted paraffine and this in turn stands in a heavy iron sink *M* well painted with asphalt. This iron sink (for which one of acid-proof stone-ware might perhaps be advantageously

substituted), is bedded in mortar on a low brick platform on the cellar floor and its outlet is trapped into the drain.

The use of hydrochloric acid so diluted with water that it scarcely fumes [specific gravity 1.11] avoids the crystallization of zinc-salts in the apparatus. To charge this generator the stop cock of *A* is opened and acid is poured in till the vessel is three-fourths filled. When by use the acid is exhausted, the cock *N* is opened, the zinc chloride solution discharged into the sink and fresh acid is supplied through one of the tubulures in *A*.

Since setting up the apparatus about three years ago the vessel *B* has never been opened and the charge of zinc is apparently far from being exhausted. It was to avoid the trouble and expense of frequent attention that this apparatus was constructed and the greatest care was exercised to make it gas-tight and durable.

Gas Desiccator.

This apparatus was designed by Prof. S. W. Johnson, Director of this Station, primarily for drying hydrogen to be used in determining water in vegetable products. It consists of nine parts, wholly of glass, viz: the waste-acid jar *a*, fig. 4 and ground glass stopper *b*, the U-tube *h* with its accessory parts, the acid bulbs *l l*, the cocks *m* and the caps *q q*. The apparatus was made in Germany to order by Messrs. Eimer & Amend and cost, duty free, between $6.00 and $7.00. *a* is a cylindrical jar 5¼ inches in diameter and 5½ inches high, having a tubulure with ground glass stopper *b* for emptying the waste acid. The U-tube is fitted to *a* by a hollow ground glass stopper. Immediately above this is a trap whose construction is sufficiently plain from the figure. When acid trickles into this trap it rises in the outer bulb *d* and passing through *e* rises equally in the inner bulb till the level is above the top of the tube *f g* through which it discharges into *a*. The U-tube *h h* is 8 inches high from *f* to *s* and 1 inch in diameter, *i* and *i* are ingress and egress tubes. Each acid bulb *l* is fitted to the U-tube by the hollow ground-glass stopper *j*. In each stopper is a single perforation which by turning the bulb may be brought to coincide with the tubes *i* and *i* and so admit gas to the U-tube. This is shown on the right of the figure. The gas is shut off by turning each bulb slightly. Through *l* passes a glass rod *m* enlarged and flattened at *p* for convenience in turning. The lower part of this rod is enlarged and carefully ground to make a

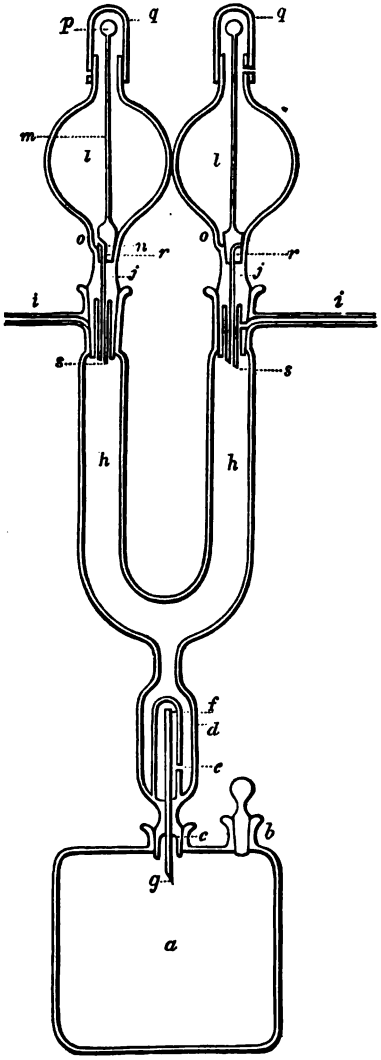


Fig. 4.

tight-stopper at and above *r* except at one point *o* where the wall of the acid bulb is expanded a little. In this section of the stopper is a perforation *n*. The perforation continues through the bulb-neck *j* to *s*. It is evident that if *l* contains acid and *p* is turned till the hole *n* is opposite *o*, passage will be opened between *l* and *h*. *q q* are caps ground to fit the shoulder of the bulbs with perforations as indicated to exclude or admit the atmospheric air. For use the apparatus is supported on a stout iron lamp-stand to whose upright each arm of the U-tube is held by a clamp. All the joints except those at *o* are smeared lightly with vaseline. The U-tubes are filled with beads or sections of glass tube about $\frac{1}{4}$ of an inch long, $\frac{1}{4}$ inch in diameter with bore of about $\frac{1}{8}$ inch. All the cocks being closed, the bulb tubes are filled with the strongest commercial oil of vitriol,* *b* is next opened and then by turning *p* and *p* acid is allowed to run over the beads in the U-tube and fill the trap *d* till it begins to discharge into *a*. The cocks are again closed as also *q q* and *b* and the apparatus may then be set aside till needed and will keep in condition for immediate use for an indefinite time.

When needed for use the hydrogen supply tube is joined with one of the tubes *i*, and the other tube *i* is connected as required, *b* is loosened and by turning *p* and *p*, acid is made to drop slowly over the beads in *h* and out from the trap into *a*. Next, both the acid bulbs are turned to open passage through the U-tube and the hydrogen is turned on at a suitable rate of flow. As the gas enters it is exposed to a large surface of concentrated oil of vitriol which does not grow sensibly weaker as in other forms of apparatus, because always renewed. As the gas leaves the U-tube it encounters a similar current of fresh oil of vitriol. The following data show its efficiency in drying hydrogen.

A stream of hydrogen was passed through a wash bottle containing 40 per cent. sodium hydrate solution, to retain a possible trace of hydrochloric acid or hydrogen sulphide and also to indicate the rate of flow, then through this drying apparatus, and afterwards through a weighed U-tube filled with broken glass, drenched with pure sulphuric acid which had been boiled in platinum to concentrate it and contained 94.17 per cent. of H_2SO_4. This was slightly stronger than the acid used in the drying apparatus at the time. Hydrogen was passed through the ap-

* We now use an acid of 97 per cent. H_2SO_4, which we have obtained from the Fairfield Chemical Co., 71 Wall St., N. Y., for two cents a pound by the carboy.

paratus at a measured rate while each of the bulbs of the drying tubes delivered a certain number of drops of oil of vitriol per minute. The results of several experiments, in which the weight of the U-tube remained fairly constant within the ordinary limits of error, are given in the following table:

No. of experiments.	Rate of flow of hydrogen. No. of minutes per liter.	No. of liters of hydrogen passed.	Flow of oil of vitriol in apparatus. No. of drops per minute.	Time of experiment in minutes.	Gain or loss of weight of U-tube in grams.
1	5⅔	5.3	18–20	30	.0000
2	4⅛	7.2	18–20	30	+.0003
3	4⅛	14.4	18–20	60	+.0003
4	4½	13.3	11–12	60	—.0005
5	3½	8.5	6– 7	30	—.0009
6	3½	8.5	6– 7	30	—.0001
7	2½	24.0	5– 8	60	.0000

Apparatus for Drying in Hydrogen.

This apparatus was devised by Mr. A. L. Winton of this Station, and has been in use for a year and a half. A in fig. 5 is a rectangular copper boiler 9 inches long, 9 inches wide and 7 inches deep, supported by iron legs. B is a stopcock, through which the tank can be emptied, and which carries a glass gauge for showing the water level, attached by a rubber stopper. Through the short tube C a thermometer may be introduced. D is a copper tube connecting with a block tin worm inside the condenser tank E, which is 9 inches long, 5 inches wide and 4 inches deep, and is held 3 inches above the boiler by copper supports. When in use, cold water is supplied to this condenser to prevent loss by evaporation from the boiler. Eight copper tubes G, arranged as in the figure, pass through the boiler horizontally. They are $\frac{9}{16}$ inch inside diameter and as long as the width of the boiler, 9 inches, and their open ends are soldered flush with the sides of the latter. The copper brackets F support the metal tubes I, through which hydrogen is supplied.

Fig. 6 shows four of the eight glass drying tubes G, attached by rubber connectors H to the copper tube I, and ready for insertion into the tubes G of fig. 5. These glass tubes, each numbered and provided with numbered cork stoppers, have the shape shown in the figure. They are 8 inches long and about ½ inch in outside diameter. For use, a small cotton plug closes the throat of the tube at J, two grams of the finely pulverized, air-dry material in which a water determination is to be made, are weighed on a watch glass and poured in through a funnel, or weighed in directly from a weighing tube, another small cotton

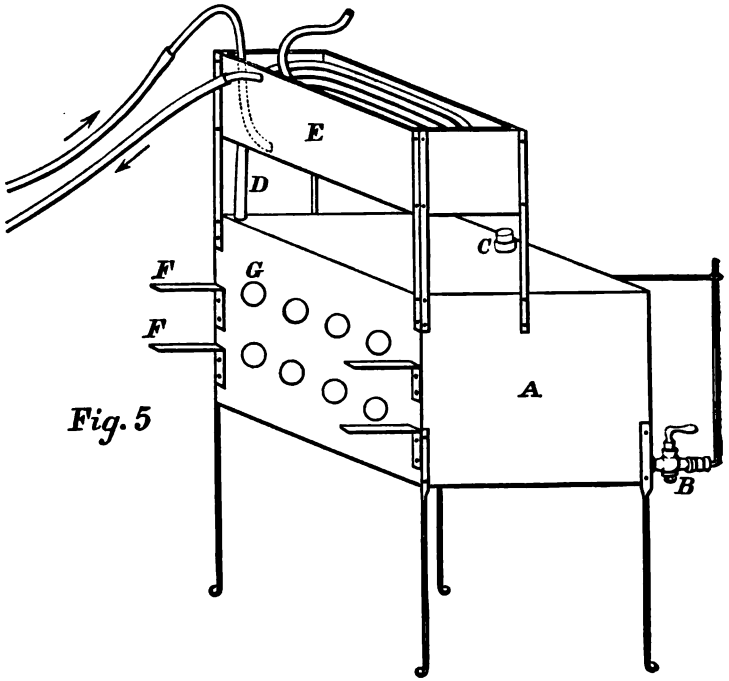


Fig. 5

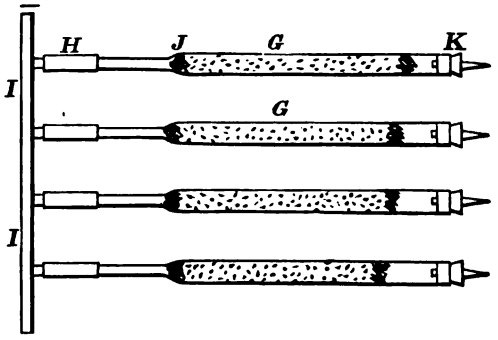


Fig. 6.

plug is inserted and the stoppers are put in place. The tubes are wiped and in 20 minutes can be weighed. They are then fitted with stoppers K, carrying glass tubes which are drawn out to a fine opening and are connected by rubber with copper tubes I. These tubes are closed at one end and have an inside diameter of ¼ inch with offsets of the same diameter as the glass tubes. A three-way glass tube with rubber connectors joins two of these copper tubes to each other and to the hydrogen supply. At first the tubes are so placed that the jets do not project beyond the side of the boiler; otherwise the moisture will condense in them. A slow current of dry hydrogen displaces the air, and after most of the moisture is gone, the gas jets are made to project and the gas lighted to show that it is passing through all the tubes. If the pressure is sufficient there will be no difficulty in distributing the hydrogen. The boiler, filled to G, with water, to which salt may be added if necessary to raise the boiling point to 100° C. is heated by a gasburner. The material is dried till repeated weighings demonstrate that the weight remains constant. From three to five hours have been found sufficient in most cases. We have practiced replacing the hydrogen in the tubes at the close of the operation by perfectly dry air before weighing.

Aliquotimeter.

The apparatus here described was made by Mr. Winton with special reference to the routine work of fertilizer analysis. To determine total phosphoric acid, 2½ or 5 grams of the phosphate, after ignition with magnesium nitrate, are brought into a half liter flask* and dissolved in hydrochloric or nitric acid. It is then necessary to make the volume of solution 500^{cc}, to pass it through a dry filter and measure off 100^{cc} for the determination. If the number of determinations is large, these operations are very tedious, when hand-pipettes are used, the least agreeable part of the work being the continued use of the mouth in filling and rinsing the pipette. A funnel and a flask are also required for each determination, thus adding considerably to the work of dish-washing. For accurate work a pipette should never be emptied by blowing into it and should be held perfectly still

* Messrs. Whitall & Tatum of N. Y., supply half liter flasks accurately graduated, in which solutions can be boiled. By their use one transference of the solution can be avoided.

while the liquid is running out, points which are sometimes disregarded, but which with the apparatus here described do not tax the operator's attention.

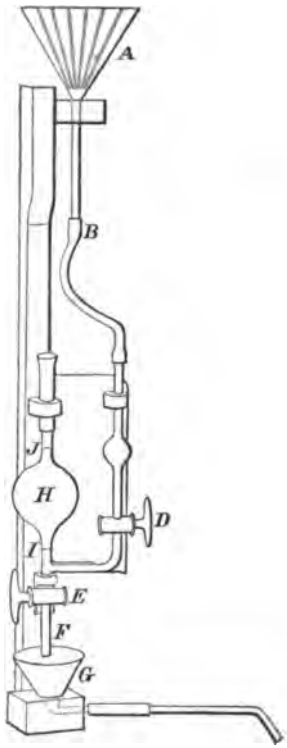


Fig. 7.

In fig. 7, H represents a pipette properly graduated to deliver 100^{cc} when the surface of the liquid falls from the mark J to I by opening the stop cock E. Below I is a branch tube having a stop cock with $\frac{1}{8}$-in. bore, D, and a small bulb which prevents bubbles of air from being carried down the tube. To this tube by the rubber at B is attached a funnel A. The apparatus is mounted on a wooden support, partly shown in the figure.

For use, D and E being closed, the solution to be measured is poured on a plain filter, contained in the funnel. When the solution has filled the funnel, D is opened and the pipette H filled. Next D is closed and E opened, and to rinse the appara-

tus, the solution is run off through G to the sink. E is again closed, D is opened and the pipette filled to the mark J. Next, D being closed, 100cc are drawn off through F into the beaker for precipitation. The filter and contents are removed and the same operations are repeated with the next solution. The waste-funnel is mounted in a block of wood with which it is pushed aside when the aliquot is drawn into a beaker.

To secure rapid filtration in the funnel A, a number of slender glass rods are disposed radially within it. They may be kept equidistant and in proper position by ligatures of thin platinum wire. Folded filters are very liable to be broken, but might doubtless be used if supported at the vertex by a platinum cone.

Apparatus for Determining Nitrogen by the Method of Kjeldahl.

1. The substance to be analyzed is weighed into long necked pear-shaped digesting flasks whose transverse diameter is about 3 inches. Ten of these are firmly supported in a portable box or frame of light wood (not figured) carrying two horizontal shelves 21 inches long, 8 inches wide and 6 inches apart, the lower one having two rows of 2¼ inch holes over which the flasks rest, the upper shelf being divided lengthwise into three sections. Of these the two outer ones are fixed to the frame: they are 2 inches wide and each has on its inner edge five notches of about 1 inch depth which engage the necks of the flasks. The third movable section, 4 inches wide, when put in place secures the flasks in a nearly vertical position.

2. The sulphuric acid is measured into the digesting flasks by help of the arrangement *a*, *b*, *c* shown at the right in figure 8. The H_2SO_4 reservoir *a* of 4 liters capacity is supported on a shelf. It is closed by a rubber stopper through which pass two glass tubes. One of these communicates with the exterior air through an oil of vitriol trap to exclude ammonia. The other is a syphon whose short arm (erroneously figured) reaches to the bottom of *a*, and whose long arm is provided with a cock, and connects by a rubber stopper with the measuring cylinder *b*. Except when *b* is in actual use, the upper lateral cock is kept closed. The delivery tube must be rinsed with a little acid just before using to remove any absorbed ammonia. When *b* is not in use, the small beaker *d*, supported by a hinged wire, is brought under *c*

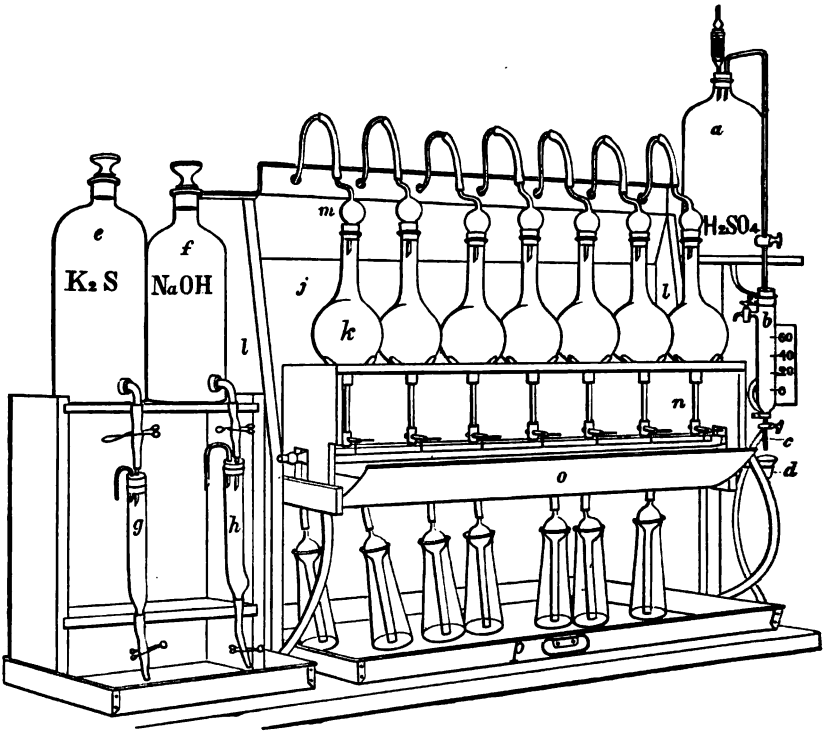


Fig. 8.

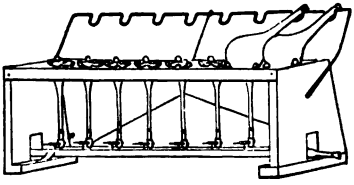


Fig. 9.

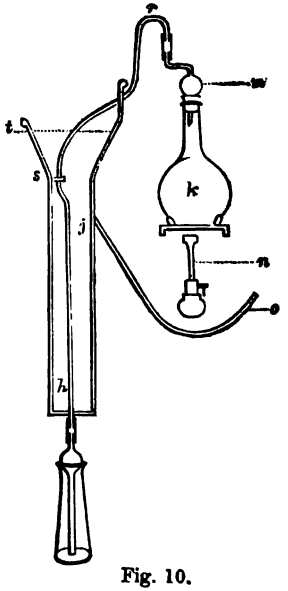


Fig. 10.

to catch the drip. The cylinder *b* is secured to the vertical edge of a fixed wooden support by means of tin-plate clamps and wood-screws.

3. The digestion flasks charged with acid and mercuric oxide are next placed on the lamp stand, fig. 9, which is made of stout sheet iron. The ends as seen in cut, measure 6 inches high, 6 inches wide at top and 7½ inches at bottom. Each end is made from a piece of iron so large that by turning its edges at right angles and cutting away the overlapping corners, a flange is made 2 inches wide at bottom and 1 inch wide on the top and sides. Each end is notched below to admit the long gas tube which bears the Bunsen burners. An iron sheet 13 inches wide and (for 8 flasks), 37 inches long is bent lengthwise at nearly right angles one inch from one edge and again at about 6 inches from the other edge to form a top, a back and a narrow front to the stand. This piece of metal is finally riveted to the inch flanges of the end pieces above described.

Before bending however, 8 holes are cut in the top section as follows :—Draw a line 4 inches from and parallel to the edge of the unbent plate, and from centers 4½ inches apart on this line, describe 8 equidistant circles of 3½ inches diameter ; next mark 12 equidistant points on the circumference of each circle, and from alternate points as centers draw semicircles of ⅝ inches radius within the large circles. Now cut away the metal of the large circles except so much as the small semicircles include, and bend upwards at right angles three alternate tongues, thus made, for each aperture. The necks of the flasks are supported at proper inclination by a small iron rod bent and riveted as shown in the figure. The iron ends of the stand are screwed by the bottom flange upon pine strips each 7½ by 2 by 1 inch, and the gaspipe carrying the lamps is secured to these strips by clamps or bands of sheet iron. The flasks are heated over the naked flame of Bunsen burners arranged like those of the Erlenmeyer combustion furnace. The burners are either widened out funnel-shape at the top and covered with short wire gauze caps, or longer cylindrical gauze caps are supported upon ordinary burners so that the top of the caps is ½ inch above the burner. By either arrangement the flames may be turned very low without risk of striking down or becoming smoky.

4. When the digestion is completed and after treatment with permanganate the solutions are transferred to distilling flasks of

about 600cc. capacity, *k*, fig. 8. To each flask is added 25cc. of K_2S solution from the bottle *e* by help of the measuring cylinder *g*, which swings freely by its rubber connections. From *f* a slight excess of NaOH solution [50%] is introduced and after adding a few pieces of granulated zinc and, to prevent foaming, a bit of paraffine, the flasks are mounted as shown in figures 8 and 10. Each flask is fitted with a rubber stopper carrying a spray-trap, *m*. This is a bulbed tube bent twice at right angles having a diameter of $\frac{1}{2}$ inch and bore of $\frac{3}{8}$ inch ; the diameter of the bulb is $1\frac{1}{2}$ inches. The spray-trap is joined by a rubber connector to the block tin-condensing tube *r* fig. 10, which has a bore of $\frac{1}{2}$ inch and a total length of 32 inches. This condensing tube passes vertically through an open tank made of sheet copper, *j*, and is firmly soldered into the bottom of the same but is supported above by simply passing through holes in the upper rim of the tank and in a narrow horizontal shelf at *s*, fig. 10. The dimensions of the tank with 7 condensing tubes are, length 32 inches, depth from *t* 16 inches, width at top 6 inches, at base 3 inches. The tank was widened at the top with a view to its use with ice in hot weather for alcohol estimations, etc. For ammonia-distillations simply, ice is never required and a tank of much less capacity is sufficient. Cold water is supplied at one end through a syphon, one leg of which is connected with a service pipe, the other reaching to the bottom of the tank. A short efflux tube of $\frac{1}{2}$ inch bore is soldered into the other end of the tank at the level of *t*. The flasks are heated by gauze-capped Bunsen burners *n* and are supported on an iron shelf quite similar to that represented in fig. 9.

The distillates are received in so-called precipitating jars of about 7 inches height. The tin condensing tubes which project underneath some three inches are joined by rubber connections to bulbed tubes which should be somewhat shorter than shown in figure 8 so as to just dip into the standard acid in the jars. These tubes are of $\frac{3}{4}$ in. caliber at the widest, except the bulbs which are about $1\frac{3}{4}$ inches in diameter. The bulbs serve as covers for the jars and assist to prevent loss of their contents either by spirting or regurgitation.

5. The tank when full of water requires a substantial support which consists of two uprights, *l l*, fig. 8, cut from a pine board. Each upright at the base and for half its height is 12 inches wide, at top 6 inches wide and is 27 inches high. At 11 in. from the table the base of the tank rests upon a pine shelf with holes for the

projecting tin tubes. This shelf is supported by transverse battens 18 in. long secured to the uprights and which project in front to support the lamp-stand. The uprights are kept in position by means of 4 brass rods of about $\frac{1}{8}$ inch diameter fitted with screw, nut and washer at each end. These rods traverse the uprights close to the tank, two on its opposite sides below near *h* and two above near the level of *s*. The nuts being screwed on tightly, bind the whole firmly together.

To protect the table and distillate from injury in case a distilling flask should break, the galvanized iron screen *o*, fig. 10 is employed. The lower part of this is made into a trough by suitable end pieces and at the bottom is connected with the sink by a rubber tube seen at the left in fig. 8. A half hour's distillation is sufficient to completely expel ammonia from the distilling flasks and condenser tubes. When in constant use the tank should be emptied once a week and steam blown through the condenser tubes to remove paraffine deposited in them. Glass condensing tubes are objectionable since as is well known they always yield more or less alkali to hot water or steam.

The spray-traps which were devised by Dr. Osborne are at once effectual and simple and we have repeatedly filled distilling flasks more than half full of water to which 50^{cc}. of NaOH solution was added, with granulated zinc, and boiled as fast as the full heat of the lamps would allow for half an hour and found in the distillates alkali equivalent to but 4 to 5 one-hundredths of one per cent of nitrogen reckoned on one gram of substance. When the rate of boiling is not excessive the error caused by the spray carried over is inappreciable. In a working day of seven hours one operator with one distilling apparatus and two digestion stands, can make 30 to 35 nitrogen determinations in feeding stuffs. In fertilizers fewer determinations can be made because a longer time is usually consumed in the digestions with sulphuric acid.

Drying Oven.

A fully representative sample of maize stalks, coarse grasses or other forage plants can only be secured by gathering a large quantity of the material from all parts of the field, plot or mow. This must then be so subdivided that it can be thoroughly intermixed so as to yield finally an average portion not too large to be ground to a fine meal suitable for analysis.

Fresh material containing from 30 to 80 per cent. of water may be cut by machinery or hand into pieces from ¼ to 1 inch long, and, after thorough mixing, a fraction of the whole taken for drying. This is then dried, rough ground, and a weighed fraction of it again taken to be pulverized for analysis. Owing to the labor involved in handling the bulky material the temptation is strong to draw samples as small as may be. This always involves danger of making the sample unrepresentative and thus vitiating the results of further work. Without a fair sample the best analysis has little or no value.

A capacious drying apparatus and a mill run by a steam or gas engine makes it possible to handle large samples conveniently and greatly diminishes the risks of sampling. Every laboratory needs a large drying oven which may be left to the care of laboratory helpers without danger of damage to its contents. It must dry quickly, for slow drying is favorable to loss by fermentation; the heat, however, must not be sufficient to "cook" the samples, i. e. to disintegrate starch grains or coagulate albuminoids.

Not having live steam at our disposal the oven herewith described was constructed and has given satisfaction for the last two years. It is built in the basement of the laboratory against a broad chimney-stack which forms its rear wall, and consists of a brick-work base containing the heating apparatus and a wooden superstructure which carries the trays in which the material to be dried is spread. The full details of the carpentry cannot well be given but are simple and can be readily planned by any practical joiner. The sketch, fig. 11, will give an idea of the construction. The brick base is 32 inches high, 5 feet 6 inches long and 34 inches from front to back, outside measurement. The opening, or fire-door at the end, see fig. 11, is 18 inches wide and is closed by an asbestos board ⅜ inch thick, having a wooden base and handle on the outside. The brick-work is 4 inches thick except at the right of the fire-door where an 8-inch pier is built. In front two bricks are left out of the lower course and one brick also on the end opposite the fire-door. These are the openings of short brick flues laid on the floor which deliver cold air directly under the smoke pipe within. These openings may be closed with brick when desired. Within this enclosure stands a small cast-iron laundry stove for anthracite or coke, known in trade as "Sweetmeat No. 1." Its widest diameter is about 17 inches and its body is about 16 inches high. To save space the stove without

its legs is bedded in mortar on the floor. It is placed as near as possible to the fire-door so that coal can be conveniently supplied and ashes removed. The smoke pipe leading from stove to chimney flue is about 16 feet long and traverses the brick enclo-

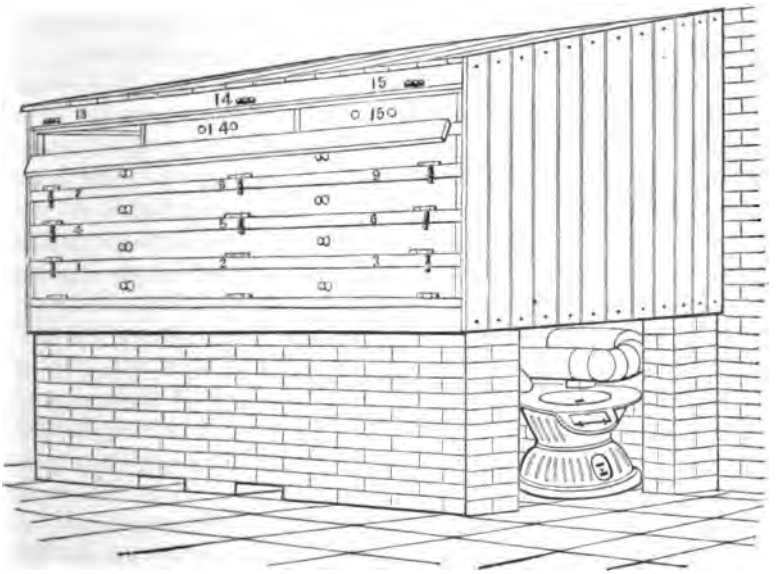


Fig. 11.

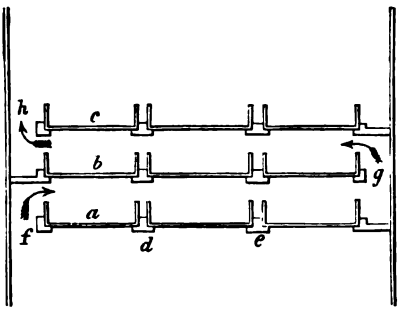


Fig. 12.

sure back and forth four times in parallel lengths (the second and third lengths being under the first and fourth), and enters the flue by a fifth short length near the fire-door. The first, fourth and fifth lengths of pipe are seen in the figure. This pipe has eleven elbows.

A screen of asbestos board $\frac{3}{8}$ of an inch thick, 4 feet 9 inches long and 34 inches wide is laid over this brick structure, covering the wall at the fire-door end, to protect the wood-work above from too intense heat. Heated air must therefore pass into the superstructure at the end furthest from the stove. The brick wall so far as not surmounted by the large asbestos board just mentioned is covered by a strip of similar asbestos about 2 inches wider than the wall itself that projects inwards to further protect the wood-work. There thus remains a horizontal opening 3 by 28 inches between the brick-work and the wood-work for the rise of heated air. The asbestos screen is supported at one side by nails driven into the chimney-stack. On the base so prepared stands the dry-house made of wood. Its outside length and width are greater than the base by the thickness of the sheathing which overlaps the brick. The house is made of $\frac{7}{8}$-inch pine boards, with exception of four sills, four posts, two plates and two rafters of 2 by 3-inch scantling. The ends are covered by vertical sheathing nailed to sills and rafters. The posts are further joined both at front and rear by six horizontal strips of $\frac{7}{8}$ pine and of 3-in. vertical width, let in flush to the faces of the posts. Through these strips at the rear the frame is spiked to the chimney wall. The upper edge of the lower strip is 8 inches above the asbestos screen and the strips above this are 3 inches apart vertically, leaving five interspaces, each of which gives room for three drawers as shown in fig. 11, for which the needful partitions and slides are suitably framed in. At the upper part of the figure two drawers, Nos. 14 and 15, are shown in place. The drawer-fronts are flush with the outside of the posts and sills. The 3-inch strips between the drawers are not seen in the figure and are covered by $1\frac{1}{2}$-inch strips nailed over their centers longitudinally, which in the cut are numbered 1 to 9. To the upper edge of each $1\frac{1}{2}$-inch strip is hinged a $4\frac{1}{2}$-inch board which serves as a door or lid to shut over the fronts of three drawers with a bearing on the drawer-frames all around, and these, together with a 7-inch board nailed on at the bottom, make a fairly tight enclosure.

The drawers or trays are each $20\frac{1}{4}$ inches wide and 34 inches long from front to rear, outside measurement. The drawer-frames are made $2\frac{1}{2}$ inches deep and the bottoms are galvanized iron netting of $\frac{1}{4}$-inch mesh secured underneath by $\frac{3}{8}$-inch strips nailed on through the netting, making a total depth of 3 inches. Two 1-inch augur holes 3 inches apart, at the middle of the drawer-

front, serve as a "pull." The fifteen trays have an aggregate area of over 60 square feet and about 12½ cubic feet content.

The interior arrangement is shown in section by fig. 12 [not to scale]. Supposing the trays all to be filled with substance to be dried resting on sheets of thin paper that completely cover the netting bottoms, the hot air rising [at the rear end of the horizontal asbestos screen placed between the brick-work and the wood-work] enters *f*, the end-space between the sheathing and the slide on which drawer *a* runs, thence it is made to pass over all the drawers in succession, its course being indicated by the arrows [alternate end-spaces, which have a horizontal measurement of 2 by 28 inches, being closed for that purpose] and finally enters the chimney just under the roof of the dry-house by a 6-inch hole that opens directly into a flue, adjoining and warmed by, the flue which carries off the smoke of the stove. The roof of the dry-house is a movable cover of battened sheathing which rests on the plates and rafters and is kept in position by the sheathing at the ends, and by notches in the rafters which engage the ends of the battens. We find it best to block up the lower edge of the cover an inch or so and let the moisture-laden air escape directly into the room.

Thermometers kept in the trays for hours while fire was burning in the stove, their bulbs being immersed in sand to hold the temperature during observations, gave the following readings in degrees Centigrade:

	12 M.	1 P. M.	3 P. M.	4 P. M.	5 P. M.
Tray No. 1	50°	46°	48°	43°	42°
" " 3	51°	50°	50°	45°	44°
" " 5	50°	46°	46°	43°	41°
" " 12	46°	40°	42°	38°	42°

Apparatus for Determining Nitric Acid.

This modification of the Schulze-Tiemann apparatus, devised by Dr. Osborne, is much more convenient for rapid work than the original. The flask *a*, Fig. 13, of about 150 c. c. capacity and of glass so thick, that it will sustain the full atmospheric pressure, is provided with a doubly perforated stopper carrying the funnel tube *b*, closed by the pinchcock *c*. The glass exit tube *d* is joined by stout rubber tubing to the three way tube *e*, as shown in the figure. One branch of this tube has a short rubber tube attached which may be closed by the pinchcock *n*. The other

branch is connected by glass and rubber tubing with the bulb *f*, which in turn is joined to the 100 c. c. burette *g*. This burette is surrounded by a water jacket so that the gas in it may be easily cooled to a constant temperature by a stream of water. The tip of the burette passes through a rubber stopper in a glass tube *h*, which forms a small reservoir for caustic soda solution used to wash the gas at the close of the operation. A second glass tube

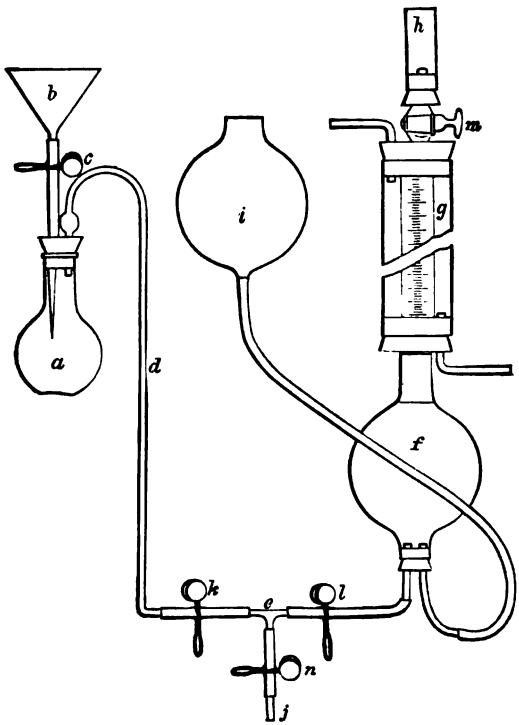


Fig. 13.

enters the bottom of the bulb *f*, and is connected by a long rubber tube to the bulb *i*, which contains a ten per cent. caustic soda solution. The substance for analysis is placed in the flask *a*, if necessary enough sodium carbonate is added to make the reaction neutral or alkaline and the flask is then two-thirds filled with freshly boiled water and the stopper inserted. The contents are then boiled down to a small volume, the steam escaping through *j*, the clamps *k* and *n* being open and *l* closed. In the mean time

the burette is filled with freshly boiled caustic soda solution by filling the bulb *i*, and raising it until the solution runs from the burette into *h*. The stopcock *m* is then closed and *i* about half filled with soda solution. When the contents of *a* have been boiled to a small volume the lamp is removed and the clamp *k* is closed and *l* opened. The soda solution will then run out through *j*, filling the tubes ; *j* is then closed and *k* opened carefully. The diminishing pressure in *a*, due to cooling, will cause the soda solution to rise in the tube *d*. When it has risen an inch or two *k* is closed and by cautiously opening *c* ferrous chloride solution is run from the funnel *b* into *a*, followed by hydrochloric acid. The clamp *c* is then closed and the lamp replaced under *a*. By opening the clamp *k* from time to time the pressure in the flask *a* can be ascertained. As soon as the solution in the tube *d* begins to fall, *k* is left open and the gas from *a* passes through the tubes into *f* and into the burette. In the meantime the bulb *i* is placed in a position below *g* in order to diminish the pressure within the burette. While collecting the gas, water is kept running through the jacket and is allowed to flow over *f*, thereby keeping the solution cool. When the gas has ceased to come off, *h* is filled with the soda solution and by opening *m* the contents are allowed to run slowly into the burette so as to wash the interior surface of the latter and remove any trace of carbonic or hydrochloric acids which it might contain. The cock *m* is then closed, the bulb *i* is raised to bring the surfaces of the solution in the bulb and in the burette to the same level and the volume of gas read. If after a few minutes the reading is unchanged the gas has been cooled sufficiently.

With this apparatus the results obtained have been in every way satisfactory and the time reduced to a minimum. Thirty to forty minutes are commonly sufficient to complete a determination. Further, if it happens that the amount of nitrate present evolves more gas than the burette will hold the boiling may be suspended, the clamp *k* closed and the evolved gas measured. The burette is then filled with soda solution again and the remaining gas collected and measured. By using a flask strong enough to sustain a complete vacuum this can be done easily and without danger.

Gas Engine and Mill.

It may not be out of place to say that the Station has used an Otto gas engine of one and a quarter horse power for the last year and a half with very satisfactory results, in connection with the Excelsior Mill noticed in our Report for 1888, page 11.

The engine was first run on June 23d, 1888, and since that time all feeding stuffs analyzed here have been ground by its power. Many of the samples have been quite large, the ease of grinding rendering it less imperative to keep the samples small than when hand power was used.

The total consumption of gas up to Sept. 1st, 1889, was 6900 feet, costing $10.35. $2.55 have been spent for oil and $1.00 in repairs.

The first cost of the engine was	$290.00
Setting, with shafting, pulleys, belting, etc.	129.91
Excelsior Mill, duty free	50.00
Setting up and connecting same	31.40
	$501.31

FIELD EXPERIMENTS.

IN 1889.

I. On the Comparative Agricultural Value of Superphosphate and certain Natural or Raw Phosphates.

For the last three years the Station, with the coöperation of farmers in different parts of the State, has carried out field experiments designed to give information on this subject. The facts which suggested the experiments may here be again briefly stated.

The market price of phosphoric acid varies greatly according to the form in which it is bought. Thus it costs in dissolved bone black about 8 cents per pound, in dissolved South Carolina rock between 5 and 6 cents, in Bolivian guano between 4 and 5 cents and in Grand Cayman's phosphate and ground South Carolina rock 3 cents per pound.

That the more expensive forms are also the ones most quickly available to plants may readily be admitted, but it is a question whether the cost prices stand always in direct relation to the agricultural value; that is, on land deficient in phosphates will $5.00 per acre spent in buying dissolved bone black for instance yield a greater or less return in the long run, than the same money spent for South Carolina rock or other raw phosphates, seeing that more than twice as much phosphoric acid can be bought for the same money in some of the cheaper forms, as can be bought in dissolved bone black?

The fact that the farmers of this State annually spend from $275,000 to $300,000 for phosphoric acid alone, makes this question practical and important.

The general plan of these experiments has been to broadcast over the whole field under experiment, a liberal quantity of nitrogenous matter and potash salts, and to divide it then into seven or more plots of equal size. On one plot a quantity of Dissolved Bone Black was used which, it was believed, would not be in excess of the needs of a full crop, but rather slightly deficient. Two other plots with no phosphates served to show what the land could produce without the addition of phosphates. On single plots, each of the other phosphates was used in such quantity, that the cost of each was just equal to the cost of the dissolved bone black on the first plot. The comparative effects were measured by the weights of the crop produced.

Mr. W. I. Bartholomew's Experiment.

The data regarding the experiment field, soil, arrangement of plots, etc., have been fully given in the Station Reports for 1887, page 110, and 1888, page 112, and need not be repeated here. Last season, the field was planted to the same variety of corn for the third successive year, after plowing, broadcasting 320 pounds of muriate of potash and 100 pounds of sulphate of ammonia per acre and harrowing. No phosphates were applied, except as mentioned below, the object being to note the after-effects of the phosphates applied in 1887.

The details of the experiment are given in Mr. Bartholomew's written report to the Director.

"In making this the third year's report of the continued field experiment with phosphates, which was commenced in the season of 1887, to ascertain the comparative values of several phosphatic materials furnished by your Station, and carried on under the direction and observation of its officers, I have but little to remark in addition to the figures which give to you the weight of the ears of corn grown on each plot this season.

At planting time, the indications were favorable for a good crop. The corn came up well and met with no accident, save that a few hills were pulled by the crows. Sufficient plants were successfully replaced in these from a bed of plants raised for such contingency, and their growth was quite similar to the others.

Differences in the appearance of the several plots were quite manifest, although on all except plot G, the corn was small, and evidently needed nourishment of some kind. Plot G alone received a supply of dissolved bone black at this planting. It had no phosphate during the two previous years, and responded quickly to the application, and the crop at harvest was not only greater in weight, but superior in ripeness and soundness to that on the other plots.

On the 20th of June, as we were hoeing the corn, I sprinkled a small quantity of dissolved bone black about the roots of the plants on three cross sections of the plots, the width of these sections being one rod each (see diagram). In two weeks this produced a visible change in the appearance of the corn to which it was applied, and there was a decided increase in the crop from the parts receiving it.

In the early part of August, after a period of extremely wet weather, a rust or blight was noticeable on the leaves over the

whole field,* which seemed to check growth and to prevent the crop from maturing as fully as it otherwise would have done, and the husks adhered closely to many of the ears, causing them to mould.

As a paying crop, this was not a success, but as showing the lasting effects of the phosphates used, as well as the ready response given to a small quantity of available phosphoric acid, although applied late in the season, I think it interesting."

The accompanying diagram will make clear the plan of the experiment. The weights of the ears harvested are given for each plot, and for each consecutive fifty hills in each plot, in pounds.

These figures show that the field was somewhat more productive on the west side, but this did not injure the experiment as all the plots ran from east to west.

The cross sections, one rod wide, referred to by Mr. Bartholomew, where a little dissolved bone black was sprinkled about the roots of the corn at hoeing time, June 20, are indicated by the full-faced figures, and show the increased yield caused by it.

This experiment has now come to a conclusion as far as the corn crop is concerned. It is necessary that some other crop should take its place. The results of the three years' planting to corn may profitably be considered together.

Results.

If we call the average yield of plots C and F, which received no phosphate, 100 per cent., the yields of the other plots expressed in per cents, are as follows:—

	Season of 1887.			
	Sound ears.	Soft ears.	Stover.	Total crop.
No phosphate	100	100	100	100
A, Dissolved Bone Black	144	67	102	111
B, Grand Cayman's Phosphate	141	64	121	119
D, Thomas-Slag	140	57	107	110
E, South Carolina Rock	118	66	99	100

	Season of 1888.			
	Sound ears.	Soft ears.	Stover.	Total crop.
No phosphate	100	100	100	100
A, Dissolved Bone Black	111	77	112	106
B, Grand Cayman's Phosphate	137	73	125	121
D, Thomas-Slag	140	65	135	125
E, South Carolina Rock	127	80	118	115

* See page 170.

A, Dissolved Bone Black put on in 1887.

12	17	10	18	21	15	18	22	24	24

Total, 176 pounds.

B, Grand Cayman's Phosphate put on in 1887.

19	29	27	20	26	26	20	26	31	31

Total, 255 pounds.

C, No Phosphate put on.

17	18	11	13	23	15	21	23	22	20

Total, 183 pounds.

D, Thomas-Slag put on in 1887.

22	32	20	25	27	25	29	31	31	32

Total, 274 pounds.

E, South Carolina Rock put on in 1887.

21	22	21	16	22	17	23	23	28	28

Total, 226 pounds.

F, No Phosphate put on in 1887.

14	19	11	12	20	10	15	23	21	23

Total, 168 pounds.

G, Gypsum, put on in 1887. Dissolved Bone Black in 1889.

28	32	20	29	29	31	27	32	31	38

Total, 297 pounds.

The plots are 2 rods wide and 10 rods long and contain one-eighth of an acre each. The hills of corn are one-fifth of a rod apart each way and the outside hills are one-tenth of a rod from the edge of the plot. Between the plots are spaces one-fifth of a rod wide and in the middle of each space is a single row of potatoes. The whole ground under experiment is surrounded by a double row of potatoes.

	Season of 1889. Sound and soft ears.
No phosphate	100
A, Dissolved Bone Black	100
B, Grand Cayman's Phosphate	145
D, Thomas-Slag	156
E, South Carolina Rock	129

1. In 1887, the year in which the phosphates were applied, equal money values of Dissolved Bone Black, Grand Cayman's Phosphate and Thomas-Slag had approximately equal effects on the yield of the corn crop. An equal money value of ground South Carolina rock produced less than half as much increase of sound ears as the other phosphates and no increase at all of stover. That is, in that season and on that land $5.00 would have paid about equally well whether it was spent for Dissolved Bone Black, Grand Cayman's Phosphate or Thomas-Slag.

2. In 1888 no phosphates were applied. The effects of Grand Cayman's Phosphate and Thomas-Slag, however, were as pronounced as they were the year before, making as large or a larger percentage increase over the plots which had received no phosphate in 1887. South Carolina Rock made a considerably larger percentage increase than the year before, showing that it was slowly becoming available in the soil.

But while Grand Cayman's Phosphate and Thomas-Slag produced nearly 40 per cent. more of sound ears and 25 per cent. more of total crop than the no-phosphate plots, Dissolved Bone Black in 1888 yielded only 11 per cent. more of sound ears and 6 per cent. more of total crop than the no-phosphate plots.

That is, the seasons and the land being such as they were, $5.00, if invested in 1887 in Grand Cayman's Phosphate or Thomas-Slag would have yielded in 1887 as much income as if invested in Dissolved Bone Black, and in 1888 would have yielded a much larger income. These facts were explained last year by showing from the analysis of the crops, that where Dissolved Bone Black was applied in 1887 there was not quite sufficient phosphoric acid left in the soil from this application to meet the requirements of the crop for 1888; therefore, it is not surprising that the yield on plot A in 1888 is but little larger than on the plot which received no phosphate in either year.

		Phosphoric acid applied in 1887.	Phosphoric acid removed by crop in 1887.	Phosphoric acid removed by crop in 1888.	Phosphoric acid remaining in the soil after the crop of 1888.
Dissolved Bone Black,	Plot A	40.6 lbs.	23.9	20.1	—3.4
Grand Cayman's Phosphate,	B	132.2	24.5	22.0	85.7
Thomas-Slag,	D	105.3	22.0	23.0	60.3
Ground S. C. Rock,	E	140.0	21.1	21.1	97.8

3. The yield of corn in 1889 was very small, as was anticipated. The stover was so damaged by continuous wet weather and blight, that it was not thought worth while to weigh it. We have therefore only the weights of the ears for comparison. From these it appears that the plot which had received Dissolved Bone Black in 1887 produced no more ears than the plots which received no phosphate then or since. This fertilizer had entirely spent itself in the two previous years. Grand Cayman's Phosphate and Thomas-Slag, however, produced 45 and 56 per cent. more corn than the no-phosphate plots, and S. C. Rock 29 per cent., a larger percentage increase, indeed, than either last year or the year before.

That is, to carry out the illustration, the investment made in Thomas-Slag, Grand Cayman's Phosphate and S. C. Rock in 1887 was still paying considerable dividends in 1889 while the investment in Dissolved Bone Black had ceased to yield any returns whatever.

On this particular piece of land and in these three seasons Thomas Slag and Grand Cayman's Phosphate have been more profitable than Dissolved Bone Black.

Mr. W. H. Yeomans' Experiments.

These are in part a continuation of the experiment begun last year and fully described in the Report for 1888, page 122, to which reference may be made for details as to the soil, arrangement of plots, method of planting, etc. Following are Mr. Yeomans' notes regarding the course of this continued experiment this year:

May 17, finished plowing.

May 23, 200 pounds sulphate of ammonia and 320 pounds of muriate of potash were spread upon the acre of land and thoroughly harrowed in. The weather having been favorable the soil was in excellent condition.

May 25, planted yellow Canada flint corn on all the plots which served for the experiment of last year.

These plots were separated from each other by a single row of potatoes as before, and received no phosphates this year.

June 1, the corn commenced to come up, presenting an even appearance.

June 9, the corn was about three inches high; all the plots looking about the same.

June 22–24, the corn was carefully hoed with no very noticeable difference in the appearance.

July 17, employed the horse hoe, although the ground was very wet, the weather having been unfavorable for nearly a fortnight.

Aug. 10, portions of the fodder are attacked by a rust. The stand on this series of plots is very uneven.

Aug. 30, plants on C and F of this series remain very small. The other plots of the series are not nearly as even in the stand of corn as last season.

Sept. 16, for the purpose of calculating to a basis of a full stand of corn of four stalks to each hill with 275 hills to each plot, which would give 1100 stalks to each plot, the stalks of the entire field were counted with the following result :

	Total number of stalks.	More, +, or less, −, stalks than a full stand.
A	1236	+136
B	981	−119
C	1031	− 69
D	956	−144
E	995	−105
F	1095	− 5
G	948	−152
H	1017	− 83

There was no lack of moisture during the growing season. The trouble this year was rather from its excess, which was so great as to prevent the necessary attention in cultivation. In the latter part of July and fore part of August one would sink into the water-soaked soil to a depth of two or three inches, it being literally mud.

Sept. 20, cut up the corn which was in fairly ripened condition; the grain of full ears being glazed over.

Oct. 5, commenced to husk; the fodder was bright and well cured.

Oct. 10, finished husking and weighed the crop.

The yield of corn and of stover reduced to a basis of 1100 stalks to a plot, 4 to a hill is as follows:—

EXPERIMENT OF 1889.

Phosphate applied in 1888.	Sound Ears.	Soft Ears.	Total Ears.	Stover.	Total Crop.
A, Dissolved Bone Black, 16 pounds	11.6	24.7	36.3	99.8	136.1
B, Grand Cayman's Phosphate, 23 pounds	3.4	44.9	48.3	123.3	171.6
C, No-Phosphate	--	12.3	12.3	55.4	67.7
D, Thomas-Slag, 27½ pounds	5.8	55.2	61.0	127.7	188.7
E, South Carolina Rock, 34½ pounds	3.6	48.7	52.3	113.9	166.2
F, Nothing	--	14.8	14.8	50.2	65.0
G, Bolivian Guano, 27½ pounds	22.0	71.4	93.4	156.6	250.0
H, Double quantity Dissolved Bone Black	29.2	62.6	91.8	152.5	244.3

If we call the average yield of the no-phosphate plots, C and F, 100 per cent. the yields of the other plots will compare as follows:—

	Ears.		Stover.		Total Crop.	
	1888	1889	1888	1889	1888	1889
C and F. No-Phosphate	100	100	100	100	100	100
A, Dissolved Bone Black	567	268	275	189	373	205
B, Grand Cayman's Phosphate	312	359	160	233	211	259
D, Thomas-Slag	211	452	136	242	161	284
E, South Carolina Rock	191	388	136	216	155	250
G, Bolivian Guano	194	692	155	296	168	377
H, Double quantity Dissolved Bone Black	550	680	387	289	442	368

Excluding the plots which received no phosphate last year the yield of sound corn, soft corn, and total crop last year and this, are as follows:—

	Sound Ears.	Soft Ears.	Total Crop. Ears and Stover.
In 1888	1558.4	764.4	5156.8
In 1889	190.4	820.0	3084.8

Examination of these results shows that the yield of corn as far as ears is concerned was almost a failure this year and that the total crop was very small.

This was due to two causes: first the condition of the soil which in farm practice would have been heavily manured last year and this year put to some other crop than corn, and secondly to the excessive wetness of the season.

The most noticeable things in this experiment are,

1. The double quantity of Dissolved Bone Black applied last year has produced about as large a relative gain this year as last.

Last year 16 pounds on plot A produced nearly as much corn as 32 pounds on plot H, which means that 16 pounds was all that the crop needed or could use last year. But the yields this year show that the extra 16 pounds remained available, and while the gain of ears on plot A this year was only 168 per cent., on plot H it was 580 per cent. over the no-phosphate plots.

2. Last year Dissolved Bone Black gave a much heavier yield than an equal money value of any other phosphate. This year it has yielded much less both of ears and stover than any other phosphate.

The probable explanation is that it contains much less phosphoric acid than either of the others, is quickly available and therefore spent itself largely last year. It is most likely that now it is entirely used up. But as has been shown in the discussion of Mr. Bartholomew's experiments, there is a considerable supply of phosphoric acid from each of the other phosphates still in the soil and becoming available as time goes on.

3. The most striking thing in the experiment of this year is the very large increase produced on the Bolivian Guano plot over the yield of the no-phosphate plots which is particularly noticeable in the ears. Whether this is due to the rapid disintegration and solution of the phosphate by a single season's exposure or to an effect on the soil produced by the large quantity of carbonate of lime contained in it, must be left for the present undecided.

4. The results of these experiments and those of Mr. Bartholomew *agree* in this that the larger part of the Dissolved Bone Black has been used up in a single year and that in the second year after application Thomas-Slag, Grand Cayman's Phosphate and South Carolina Rock even (Bolivian Guano was not included in Mr. Bartholomew's tests), have given considerably larger yields than Dissolved Bone Black.

The results *differ* from Mr. Bartholomew's in this: first that *in the first year* Dissolved Bone Black gave a much larger yield than any other phosphate and secondly, in consequence largely of the very small total crops in 1889, Dissolved Bone Black paid much better than any other phosphate, taking the two years together.

Had the land been "in better heart," to begin with, i. e. if the no-phosphate plots had produced something like as much this year as they did last the difference in profit between Dissolved Bone Black and the other phosphates would have been very much smaller.

Mr. Yeomans also repeated the experiment of 1888 on land adjacent to that occupied for the experiment just described. In 1888, plots A, B, C, D and E of this series were planted to potatoes with the use of Mapes' Potato Manure at the rate of 200 pounds per acre and plots F, G and H were cropped with buckwheat, receiving

the fertilizer named at the same rate as the other plots. These plots were plowed and fertilized on the same day with those in the other experiment. The phosphates applied were as follows:

Each plot is marked "No. 2" to distinguish it from the corresponding plot in the experiment already described.

A, No. 2, 16 pounds Dissolved Bone Black.
B, " 23 pounds Grand Cayman's Phosphate.
C, " No phosphate.
D, " 27½ pounds Thomas-Slag.
E, " 34½ pounds ground South Carolina Rock.
F, " No phosphate.
G, " 27½ pounds Bolivian Guano.
H, " 23 pounds Mona Island Phosphate.

These phosphates were applied in the hill. Plots F, G and H were planted May 25th. The weather prevented planting the other plots of the series till May 29th. The plots were hoed and cultivated at the same times as those already described.

The following observations are additional to those already given in the account of the first experiment.

June 22. Plot A No. 2 is very much ahead of all the others. H No. 2 is well advanced.

July 17. A No. 2 is much the largest, H No. 2 closely following. C and F No. 2 are larger than C and F of the other series.

Aug. 2. A No. 2 spindled out and ears setting. C No. 2 much larger than any other no-phosphate plot and nearly as large as B No. 2.

Aug. 30. C No. 2 nearly as good as B, D and E No. 2. F No. 2 is uneven and not as good as C No. 2.

The crop was cut and stacked, harvested and weighed at the same time with the other experiment.

A full stand of corn of 4 stalks to each hill would give 1100 stalks to each plot. The stalks were counted on the several plots with the following results:—

Plots.	Whole Number of stalks.	Less stalks than a full stand.
A, No. 2,	847	—253
B, "	863	—237
C, "	1002	— 98
D, "	883	—217
E, "	842	—258
F, "	706	—394
G, "	765	—335
H, "	842	—258

In the following table are given the yields of corn and of stover reduced to a basis of 1100 stalks to a plot, 4 to a hill. This reduction itself involves a certain error, for where there is less than the full stand of corn the production of the individual plants is relatively increased. To make no allowance for missing stalks, however, would occasion a much larger error.

EXPERIMENT No. 2, 1889.

Phosphate applied in 1889.	Sound ears.	Soft ears.	Total ears.	Stover.	Total crop.
A, No. 2, Dissolved Bone Black	176.6	41.6	218.2	251.9	470.1
B, " Grand Cayman's Phosphate,	28.2	95.6	123.8	123.6	247.4
C, " No-phosphate	8.8	50.5	59.3	143.7	203.0
D, " Thomas-Slag	59.8	78.5	138.3	168.2	306.5
E, " Ground So. Carolina Rock	30.0	83.0	113.0	156.8	269.8
F, " No-phosphate	9.3	40.5	49.8	96.6	146.4
G, " Bolivian Guano	7.2	50.3	57.5	125.1	182.6
H, " Mona Island Phosphate	3.9	60.7	64.6	146.3	210.9

If we call the average yield of the no-phosphate plots, C and F, 100 per cent., the yields of the other plots will compare as follows :—

	Ears.	Stover.	Total crop.
C and F, No-phosphate	100	100	100
A, Dissolved Bone Black	400	209	270
B, Grand Cayman's Phosphate	227	103	142
D, Thomas-Slag	254	140	176
E, Ground So. Carolina Rock	207	131	154
G, Bolivian Guano	106	104	104
H, Mona Island Phosphate	118	122	121

The yield of ears on the duplicate plots, C and F, is nearly enough alike, but the differences in stover are too large, 49 pounds. In consequence, a difference of 20 per cent. in the stover or 17 per cent. in the total crop cannot be ascribed to any thing but the lack of uniformity in the soil.

Results.—1. The total crop of sound corn is small, as was to be expected from the exhausted land which was purposely chosen as most likely to be suitable for the experiment. The largest yield was at the rate of 3532 pounds of sound ears to the acre, or, allowing one-fifth for cob and 50 lbs. to the bushel of new shelled corn, 56 bushels of shelled corn per acre and the next largest yield was scarcely 20 bushels.

2. The Dissolved Bone Black plot was the only one which produced more sound ears than soft ears.

3. The Dissolved Bone Black plot yielded four times as much ears and twice as much stover as the no-phosphate plots, 1¾ times as much ears as Thomas-Slag or Grand Cayman's Phosphate, and nearly twice as much as South Carolina Rock.

4. Bolivian Guano and Mona Island Phosphate made little increase of crop.

5. In general the results confirm those obtained by Mr. Yeomans last year and given in our Report for 1888.

On this exhausted land with a liberal application of nitrogenous matter and potash salts soluble phosphates have increased the corn crop most remarkably.

Mr. C. A. Sill's Experiments.

One quarter of the field used last year for a similar experiment, Report for 1888, p. 127, was planted to corn as before, after plowing and sowing the same quantity of nitrogenous matter and potash salts as were used on an equal area last year. No additional phosphates were used. The yield of ears and stover was as follows, from $\frac{1}{10}$-acre plots:—

Phosphates applied in 1888.	Ears.	Stover.	Total crop.
A, Dissolved Bone Black	72	115	187
B, Grand Cayman's Phosphate	83	125	208
C, No-phosphate	66½	130	196½
D, Thomas-Slag	69	110	179
E, South Carolina Rock	74	119	193
F, No-phosphate	60	115	175
G, Bolivian Guano	65	116	181

The results, in connection with those of last year, furnish no information regarding the relative agricultural value of the phosphates, because the land is not sufficiently deficient in assimilable phosphoric acid to be suited to this experiment.

In another part of Mr. Sill's farm a two-acre piece was selected for a phosphate experiment, which it was believed would show less inequality in the soil and respond more decidedly to phosphatic fertilizers. It was a level piece and can be best described as a "run-out pasture." No manure had been put on for a long time, and it had lain in grass for years, being pastured occasionally with sheep but now bore more weeds than grass. This piece of land was plowed, muriate of potash and sulphate of ammonia were evenly broadcast over it* at the rate of 640 pounds and 400 pounds respectively per acre, and after harrowing, was laid off

* Excepting plots I and J, which will be spoken of later.

into eighteen plots, each covering $\frac{1}{10}$ of an acre. One fifth of an acre was left in vacant spaces between the plots. The plan was to have duplicate plots for each phosphate, and four plots with no phosphate, so as to insure greater accuracy in the results.

The crop was planted, cultivated and harvested in the usual way. The stand of corn was very even and grew without accident. The arrangement of plots can best be understood by the following diagram which also shows the quantity of phosphates used.

Plot I received its share of the ammonia salts but no muriate of potash; plot J received muriate of potash but no ammonia salts.

The phosphates were put in the hill. The quantities represent the same money values.

The weights of the crops were as follows:

		Sound ears.	Soft ears.	Stover.	Total crop.
Potash alone,	J	34	30	208	272
Nitrogen alone,	I	139	21	306	466
Nitrogen and Potash, no-phosphate,	C1....	177	23	234	434
" " " "	C2....	187	18	210	415
" " " "	F1....	246	10	229	485
" " " "	F2....	168	15	239	422
" " " Dissolved Bone Black,	A1....	254	18	246	518
" " " " "	A2....	237	13	221	471
" " " Grand Cayman's,	B1....	243	18	214	475
" " " " "	B2....	211	24	243	478
" " " Thomas-Slag,	D1....	225	17	208	450
" " " " "	D2....	196	20	223	419
" " " So. Carolina Rock,	E1....	294(?)	23	236	553
" " " " "	E2....	195	13	209	417
" " " Bolivian Guano,	G1....	222	28	242	492
" " " " "	G2....	174	21	220	415
" " " Mona Island,	H1....	210	32	214	456
" " " " "	H2....	164	18	218	400

These results are evidently of little use for the purposes of our experiment, chiefly for the reasons that the land is not perfectly uniform in crop-producing power and that available phosphoric acid is not strikingly deficient in the soil, and hence the addition of more produces no decided increase of crop. Thus the highest yield from Bone Black was less than 7 per cent. more than the highest yield where no phosphate was applied, and the average yield of the two Dissolved Bone Black plots was less than 13 per cent. more than the average of the four no-phosphate plots.

J Received potash, but no phosphate nor nitrogen.	I Received nitrogen, but no phosphate nor potash.
A2 Dissolved Bone Black, 26 lbs.	B1 Grand Cayman's Phosphate, 37 lbs.
C2 No phosphate.	D1 Thomas-Slag, 45 lbs.
E2 Ground South Carolina Rock, 56 lbs.	C1 No phosphate.
G2 Bolivian Guano, 45 lbs.	H1 Mona Island Guano, 37 lbs.
B2 Grand Cayman's Phosphate, 37 lbs.	A1 Dissolved Bone Black, 26 lbs.
D2 Thomas-Slag, 45 lbs.	F1 No phosphate.
F2 No phosphate.	E1 Ground South Carolina Rock, 56 lbs.
H2 Mona Island Guano, 37 lbs.	G1 Bolivian Guano, 45 lbs.

It is clear too that potash is not the lacking element of plant food (compare the yield of I with those of C and F) but that at present this land would be most benefited by applications of nitrogenous matters. A liberal application of cotton seed meal or of nitrogen from some other cheap source, or, now that there is a great abundance of potash and phosphoric acid in the soil, a crop of clover or of cow peas turned under would be the most profitable way of enriching it. Possibly alfalfa could profitably be grown there.

In the Report for 1888 the following offer was made:

"To any in the State who may wish to test the effect of raw phosphates on their land for themselves and will engage to follow the Station's directions for making the test and will report the results to the Station for general use, the Station will supply these phosphates so far as it is possible."

Mr. Doyle, of Harwinton, and Mr. Dean, of Falls Village, accepted this offer and the results of their experiments follow.

Mr. L. Doyle's Experiment.

A single experiment with potatoes was made by Mr. Lawrence Doyle, of Harwinton. The soil was a sandy loam. The plots were each $\frac{1}{10}$ acre. The fertilizer-chemicals and phosphates were the same as those used in the experiments above described. The seed was Early Rose, and the tubers would weigh from one-half to three-quarters of a pound apiece and were cut to two and three eyes.

Plowed April 23, planted May 8, phosphates applied May 14, cultivated and hoed twice. Applied Paris green three times. July 10 the blight appeared.

The yields were as follows:

A, Dissolved Bone Black, 26 pounds	466	pounds potatoes.
B, Grand Cayman's Phosphate, 37 pounds	408	" "
C, No-phosphate	322	" "
D, Thomas-Slag, 45 pounds	512	" "
E, South Carolina Rock, 56 pounds	356	" "
F, No-phosphate	226	" "
G, Bolivian Guano, 45 pounds	276	" "
H, double quantity Bone Black, 52 pounds	488	" "
J, No-phosphate	206	" "
K, Mona Island Phosphate, 37 pounds	250	" "

Each of these plots had four rows, 108 hills in each row and the hills were 3½ feet apart each way.

A single row by the side of plot A received no fertilizer of any kind and yielded 60 pounds of potatoes, which is at the rate of 240 pounds to a plot of the same size of the others. It was noticed that the soil at the east end, plot A, was a dark loam and became somewhat lighter and more sandy toward the west side, plot K. The no-phosphate plots show also that the west side of the field was considerably the poorer in plant food and that a close comparison of the crops cannot properly be at-

tempted. All the phosphatic applications evidently had some good effect, but the highest yield was from Thomas-Slag, D, which in this experiment appears to have been almost as readily available a source of phosphoric acid as Dissolved Bone Black itself.

Mr. M. H. Dean's Experiment.

Two experiments were carried out on different fields, one at Lime Rock in the river valley, the other on high land some two miles away. The former showed no marked effect from any phosphate and therefore receives no further notice. The results of the latter are here tabulated. 160 pounds of muriate of potash and 100 pounds of sulphate of ammonia were broadcast over the half acre, after plowing, and harrowed in. Half of each phosphate was broadcast on the $\frac{1}{20}$ acre plot assigned to it and harrowed in while the other half was put in the hill. The field was planted May 22, cut September 14–17, and harvested and weighed October 16.

On the north half of each plot was planted an 8-rowed yellow corn, on the south half a variety furnished by the Storrs School Station. Following are the weights obtained:

	North Half.			South Half.			Total.		
	Good ears.	Soft ears.	Stover.	Good ears.	Soft ears.	Stover.	Ears.	Stover.	Total Yield
A, Dissolved Bone Black	130	6	164	107	18	127	261	291	552
B, Grand Cayman's Phosphate	90	14	114	77	23	115	204	229	433
C, No-phosphate	75	17	102	53	23	94	168	196	364
D, Thomas-Slag	109	9	127	45	19	137	182	264	446
E, S. C. Rock	77	15	105	43	24	87	159	192	351
F, No-phosphate	69	20	103	30	26	82	145	185	330
G, Bolivian Guano	86	11	108	41	21	80	159	188	347
H, No-phosphate	67	22	108	45	27	95	161	203	364
I, Dissolved Bone Black	131	10	162	109	14	140	264	303	567
J, Mona Island Guano	95	13	133	82	20	130	210	263	473
4 sq. rods adjoining without fertilizer	62	19	101	...	..	...	(162)	(202)	(364)

The yield in almost every case is considerably larger on the northern half of each plot than on the south half.

The yield of ears and stover is fairly uniform on each of the three no-phosphate plots C, F and H.

If we call the average yield of these three plots 100 per cent. the comparative yields of the other plots will be as follows:

	Ears.	Stover.	Total crop.
No-phosphate plots	100	100	100
Dissolved Bone Black, 13 pounds	165	149	156
Grand Cayman's Phosphate, 18½ pounds	129	118	122
Thomas-Slag, 22½ pounds	115	135	126
South Carolina Rock, 18 pounds	100	98	100
Bolivian Guano, 21½ pounds	100	96	99
Double quantity Dissolved Bone Black, 26 pounds	167	155	161
Mona Island Guano	133	135	135
No fertilizer of any kind	102	104	104

Results.—1. Bolivian Guano and South Carolina Rock have produced absolutely no increase either in ears or stover over the no-phosphate plots.

2. Dissolved Bone Black has produced the highest yield, more than 50 per cent. larger than where no phosphate was applied.

3. Mona Island Guano ranks next to Dissolved Bone Black, while Thomas-Slag and Grand Cayman's Phosphate rank nearly alike and gave not quite half as large an increase over the yield of the no-phosphate plots as Dissolved Bone Black gave.

II.—The Effect of the Rate or Distance of Planting on the Quantity and Quality of the Maize Crop.

Field Trials of 1889.

On pages 9–48 of this Report are discussed the results of an experiment on this subject carried out in 1888 on the farm of the late Mr. J. J. Webb of Hamden.

This experiment has been in part repeated in 1889 in the same field. Mr. James H. Webb of New Haven very generously put this land at our disposal, as his father had done the year before, with the necessary help, teams and tools. We are also indebted to the foreman, Mr. Gage, for his coöperation and care in cultivating and harvesting the crop.

The details of planting, cultivation, cutting and harvesting were the same as the year before, where the contrary is not stated, and have been described on pages 11–15.

The plots used were those known last year as G, H, I, J, K, L (see page 12). The seed was White Edge Dent. The fertilizer was prepared in the same way as in 1888, used in the same quantity and the distance of planting was the same also.

The field was planted on May 17. The crop came up very evenly and when a few inches high was thinned to secure just the stand desired on the several plots. It grew without accident, was kept very clean of weeds and thoroughly cultivated, and was cut and stacked September 25. It was husked and weighed on October 31.

This experiment may be considered an exact duplicate of the experiment of the previous year on plots A, B, C, D, E, F, though grown not on the same but on an adjacent row of plots. To facilitate comparison therefore the plots in this last experiment will be designated by these same letters, A, B, C, etc.

RESULTS OF THE EXPERIMENT.

A. QUANTITY OF CROPS.

Effect of Distance of Planting on the Gross Yield and also on the Amount of Water-free Crop.

Table I which follows shows that while the gross yield constantly increased with the thickness of planting, the *dry matter* or nutritive substance of the crop increased with the thickness of planting up to a certain point (two stalks to a foot), and then decreased again with still closer planting, so that when the stalks stood more than two to a foot the increased gross yield was wholly water, and contained actually less nutritive matter than where the stand was one stalk to a foot. The experiment of 1888 gave the same results, see page 18.

Table I.—Weight of the Field-cured Crops; Gross Yield and Dry Matter.—Pounds per 1-20th Acre.

	Gross yield.	Dry Matter in Field-cured Crops.
Plot A, One stalk in four feet	168.	104.3
" B, " " two "	320.	201.6
" C, " " to a foot	457.5	307.2
" D, Two stalks " "	491.0	**317.6**
" E, Four " " "	522.0	297.2
" F, Eight " " "	**532.0**	260.3

Dry Matter in the Kernels, Cobs and Stover of the Water-free Crops.

Table II shows that the largest yield of kernels, as also of cobs, was grown where the stalks stood one to a foot, plot C, and the yields decreased rapidly where the seeding was either thicker or thinner. Thicker seeding yielded more stover and the maximum stover crop was on plot E, four stalks to a foot.—In 1888 the maximum yield of ears was on plot D, *two* stalks to a foot, and the closest planting, plot F, yielded most stover, see page 19.—No attempt was made this year to separate marketable ears from "nubbins." There were very few soft or moldy ears even where the planting was thickest. The ears on plots A, B and C were all fair and of good size, those on D were smaller but generally good, while all those on E and F were very small and largely misshapen—"hog corn."

Table II.—Total Yields of Water-free Kernels, Cobs and Stover.—Pounds per 1-20th Acre.

	Kernels.	Cobs.	Stover.
Plot A, One stalk in four feet	50.5	11.8	42.0
" B, " " two "	102.2	20.4	79.0
" C, " " to a foot	**145.3**	**32.1**	129.8
" D, Two stalks " "	105.4	21.1	191.1
" E, Four " " "	71.4	19.1	**206.7**
" F, Eight " " "	48.4	13.5	198.4

Percentage of Kernels, Cobs and Stover in the Water-free Crops.

The following table, Table III, is of per cents, and shows that the *proportion* of kernels was largest on the plot where the stalks stood one in two feet, i. e. with very thin planting, and that the proportion rapidly decreased when the stand was thicker than one to a foot. Naturally the *proportion* of stover to total crop was largest where the stand was closest. The same fact appeared in the experiment of the previous year (see page 21).

Table III.—Percentage Parts of the Water-free Crop.

	Kernels.	Cobs.	Stover.
Plot A, One stalk in four feet.	48.4	**11.3**	40.3
" B, " " two "	**50.7**	10.1	39.2
" C, " " to a foot	47.3	10.4	42.3
" D, Two stalks " "	33.1	6.6	60.3
" E, Four " " "	24.0	6.4	69.6
" F, Eight " " "	18.6	5.1	**76.3**

B. CHEMICAL COMPOSITION OF THE CROPS.

Percentage Composition of the Field-cured Crops.

The following tables, Tables IV and V, show the composition of the field-cured crop and its parts. The water content of the crops being quite different, a better comparison of their chemical composition can be made by reducing the analyses to the basis of dry matter as is done further on. These tables furnish the data for this reduction and are here introduced simply as matter of record.

The crops on the plots A, B, C and D have *approximately* the same percentage of water, while those on E and F have a considerably higher percentage.

Table IV.—Percentage Composition of the Field-cured Crops.

	Water.	Ash.	Albuminoids (N. x 6.25).	Fiber.	Nitrogen free Extract.	Crude Fat.
A, One stalk in four feet	37.9	2.2	5.4	11.7	40.8	2.0
B, " " two "	37.1	2.1	5.0	11.6	42.0	2.2
C, " " to a foot	32.9	2.3	4.3	13.0	45.4	2.1
D, Two stalks " "	35.3	2.3	3.7	15.5	41.4	1.8
E, Four " " "	43.1	2.1	3.2	14.9	35.3	1.4
F, Eight " " "	51.0	2.1	2.9	13.9	28.9	1.2

Table V.—Percentage Composition of the Separate Parts of the Field-cured Crops.

Kernels.						
A, One stalk in four feet	32.99	1.08	8.15	1.77	52.22	3.79
B, " " two "	33.52	1.04	7.76	1.52	52.28	3.88
C, " " to a foot	31.19	.93	5.78	1.57	57.03	3.50
D, Two stalks " "	28.91	.77	5.87	1.39	59.40	3.66
F, Four " " "	34.68	.72	5.20	1.39	54.73	3.28
F, Eight " " "	39.28	.69	5.28	1.35	50.45	2.95
Cobs.						
A, One stalk in four feet	46.56	.78	1.13	17.54	33.65	.34
B, " " two "	37.48	.68	1.12	21.88	38.53	.31
C, " " to a foot	43.51	.93	1.08	20.39	33.71	.38
D, Two stalks " "	45.00	.91	1.33	18.57	33.95	.24
E, Four " " "	48.16	1.08	1.52	17.06	31.85	.33
F, Eight " " "	44.98	1.06	1.61	18.83	33.17	.35
Stover.						
A, One stalk in four feet	40.54	3.91	3.91	20.31	30.54	.79
B, " " two "	40.89	3.82	2.92	20.73	30.92	.72
C, " " to a foot	31.53	4.22	3.56	23.66	36.10	.93
D, Two stalks " "	37.22	3.23	3.01	22.02	33.42	1.10
E, Four " " "	45.01	2.56	2.80	18.66	29.93	1.04
F, Eight " " "	53.63	2.46	2.52	15.92	24.53	.94

Percentage Composition of the Dry Matter in the Field-cured Crops.

Table VI shows the percentage composition of the dry matter in the several crops and brings out the following facts:

Ash.—The per cent. of ash is practically the same in the crop of each plot except F. In 1888 it is nearly alike in all but A, which suggests that these two exceptions are accidental, due, perhaps, to unobserved errors in the work. See page 27.

Albuminoids.—The highest per cent. of albuminoids was found where the planting was thinnest, showing that there the food product was the most "concentrated," concentration being measured by the nutritive ratio, i. e. the ratio between digestible albuminoids and digestible non-nitrogenous matter: fat, fibre and nitrogen-free extract. The per cent. of albuminoids quite regularly and rapidly decreased as the stand of maize was closer. In the previous year the result was the same. Between the thinnest and closest planting there was a difference of about 3 per cent. in the albuminoids. Where the maize stood one stalk in four feet in the rows, the crop, *pound for pound*, contained over one and a half times as much albuminoids as where the stalks stood eight to a foot in the rows.

Fiber.—The per cent. of fiber, both in 1888 and 1889, quite regularly increased as the stand grew closer, being largest on plot F.

Nitrogen-free Extract.—The per cent. was largest where the stand was one stalk to a foot, but not very different in the two plots on which the stand was thinner. The previous year two stalks to a foot produced the largest per cent., with rapid decrease where the stand was thinner.

Fat, or Ether Extract.—The per cent. was highest where the crop stood one stalk in two feet in the row and decreased with the closeness of the stand. The same was true in 1888.

Table VI.—Percentage Composition of the Dry Matter in the Field-cured Crops.

	Ash.	Albuminoids. (N x6.25.)	Fiber.	Nitrogen-free Extract.	Crude Fat.
A, One stalk in four feet.....	3.6	**3.7**	18.8	65.7	3.2
B, " " two feet	3.3	7.9	18.4	66.9	**3.5**
C. " " to a foot.....	3.4	6.4	19.4	**67.7**	3.1
D, Two stalks to a foot.....	3.5	5.7	24.1	63.9	2.8
E, Four " "	3.7	5.6	26 4	61.8	2.5
F, Eight " "	**4.3**	5.9	**28.3**	59.0	2.5

Total Quantities of Water, Ash, Albuminoids, etc., Harvested from each Plot.

The following table, Table VII, calculated from those previously given, shows the actual yield of each food ingredient and the real value of each crop.

It appears that plot C, where the rate of planting was one stalk to a foot in the row,—the rows were four feet apart,—produced the most albuminoids, nitrogen-free extract and fat, therefore the most cattle food. Hence in this season, and on this land, that rate of planting was more profitable than any of the others, and the best *possible* rate would have been either this or a little closer, perhaps one stalk in ten inches.

Plot D yielded 10 pounds more of dry matter than C, but 16 pounds more of fiber and correspondingly less of the more valuable food ingredients.

Under the conditions of this experiment, to get as much real feed as was raised on an acre of maize planted one stalk to a foot in the row,—rows four feet apart,—would have required one and a third acres if planted at the rate of eight stalks to a foot in the row, and the handling of a ton and a half more of water in the crop when field-cured, to say nothing of the extra quantity handled at cutting time.

In 1888 "a stand of one plant to a foot produced more of every ingredient except fiber than a stand of four to a foot, so the rate which would have given the maximum yield was either two to a foot or between one and two to a foot." Page 30.

Table VII.—Total Production of each Food Ingredient of the Crop on each Plot.

Pounds per 1-20th Acre.

	Field-cured.	Dry Matter.	Water.	Ash.	Albuminoids. (N. x6.25)	Fiber.	Nitrogen-free Extract.	Fat.
A, One stalk in four feet	168.0	104.3	63.75	3.74	9.15	19.55	68.33	3.48
B, " " two "	320.0	201.6	118.40	6.92	16.20	37.17	134.28	7.03
C, " " to a foot..	457.5	307.2	150.29	10.40	**19.67**	59.83	**207.78**	**9.46**
D, Two stalks " ..	491.0	**317.6**	173.43	11.32	18.37	76.22	202.80	8.86
E, Four " " ..	522.0	297.2	224.84	10.81	16.76	**77.95**	184.03	7.61
F, Eight " " ..	**532.0**	260.3	**271.75**	**11.33**	15.38	73.80	153.28	6.46

Comparative Development of the Individual Maize Plant.

The largest yield of the three most valuable food ingredients, as the last table shows, was from plot C, where the rate of planting was one stalk to a foot. There were on this plot 544 maize plants. Now, while the yield on plots A and B was considerably smaller the *number of plants* was likewise much smaller. To ascertain then the comparative productiveness of the *individual maize plant* the total production of each plot must be divided in each case by the number of plants on the plot. For convenience, these quotients have been multiplied by 1,000, and in the two following tables are stated the yield of 1,000 maize plants for each of the distances planted, omitting fractions of a pound.

From these tables it appears that a single maize plant produced most where the stand was thinnest, one stalk in four feet, plot A, i. e. where it had most room to grow in, though the difference is not large between this and B where the stand was twice as close. The production of the single plant is still further reduced when the number of stalks is again doubled, plot C, but as has been seen, this plot produced the maximum *total* yield, i. e. the decrease in the productiveness due to crowding the plants is much more than compensated by the greater number of plants raised. But when the number of plants is again doubled, the decrease of productiveness of the individual plants due to crowding is not compensated by the increase in the number of plants, and so the total crop is lessened. For the four rates of planting represented by plots C, D, E, and F, doubling the rate of planting in each case about halves the crop production *of a single* plant.

The same holds true for each single food ingredient of the crop. See also the discussion on pages 30–34.

Table VIII.—Comparative Development of the Maize Plant.

Pounds of Product from 1000 Seed Kernels for each of the Distances named.

	Field-cured	Water-free			
	Total crop.	Total crop.	Kernels.	Cobs.	Stover.
A, One stalk in four feet.....	**1236**	**767**	371	**87**	**309**
B, " " two "	1176	741	**376**	75	290
C, " " to a foot.....	841	565	267	59	239
D, Two stalks " "	451	292	97	19	176
E, Four " " "	239	137	32	9	96
F, Eight " " "	122	60	11	3	46

TABLE IX.—COMPARATIVE DEVELOPMENT OF THE MAIZE PLANT.

Pounds of Ash, Albuminoids, etc., in 1000 plants, for each of the Distances named.

	Dry weight.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
A, One stalk in four feet...	767	27	67	144	502	27
B, " " two " ...	741	25	59	137	495	25
C, " " to a foot...	564	19	35	110	382	18
D, Two stalks " " ...	292	10	17	70	186	9
E, Four " " " ...	137	5	8	36	84	4
F, Eight " " " ...	59	3	4	17	35	2

POUNDS OF NITROGEN, PHOSPHORIC ACID AND POTASH CONTAINED IN THE CROPS PER ACRE.

The following table, Table X, gives the pounds *per acre* of nitrogen, phosphoric acid and potash taken from the land by the crops on the several plots in 1889. With these data are also given for comparison the quantities of the ingredients mentioned which were removed from the corresponding plots of dent maize in 1888.*

TABLE X.—POUNDS OF NITROGEN, PHOSPHORIC ACID AND POTASH PUT ON IN FERTILIZERS AND REMOVED IN CROPS OF DENT CORN PER ACRE IN 1888 AND 1889.

	Nitrogen. Pounds.		Phosphoric Acid. Pounds.		Potash. Pounds.	
	1888.	1889.	1888.	1889.	1888.	1889.
Put on in the Fertilizer....	*45.1*	*45.1*	*107.2*	*107.2*	*77.8*	*77.8*
Taken off in the crop:						
A, One stalk in four feet..	57.3	29.2	21.2	14.0	49.9	23.0
B, " " two " ..	89.9	51.8	36.9	27.7	48.6	39.8
C, " " to a foot..	94.0	63.0	38.5	29.9	48.5	51.7
D, Two stalks " " ..	95.7	58.8	40.2.	27.5	51.7	45.4
E, Four " " " ..	75.3	53.6	34.1	22.2	41.5	40.3
F, Eight " " " ..	67.8	49.2	27.2	17.1	34.7	44.0

The rates of planting on plots C and D—one stalk to a foot and two stalks to a foot—are nearest to general farm practice, and the average quantities of nitrogen, phosphoric acid and potash removed in 1889 by the crops on these plots, calculated to the acre would be—

* It should be kept in mind that the plots bearing dent maize in 1888 were not the same ones which bore it in 1889 but were adjacent to them. See page 219. These dent maize plots of 1889 bore flint maize in 1888, but as may be seen from page 35 the quantities of nitrogen, phosphoric acid and potash removed by the flint maize crop in 1888 were very nearly the same as those removed by the dent maize in the same year.

Nitrogen	60.9 pounds.
Phosphoric Acid	28 7 "
Potash	48.5 "

The total crop on these two plots in 1889 represents a production of 6248 pounds of dry matter per acre, or 2507 pounds of water-free kernels. It is usual, however, to measure crops rather by the bushels of shelled corn per acre. New corn dry enough to shell, contains about 20 per cent. of water and weighs about 50 pounds per struck bushel, so that this corn crop on plots C and D averaged about 63 bushels to the acre.

In 1888 the corresponding yield was 3124 pounds of dry sound shelled corn, or about 78 bushels of marketable shelled corn. Following are the quantities of the ingredients named contained in the two crops of white-edged Dent, ears and stover, of 1888 and 1889 *calculated to a yield of 75 bushels per acre.*

	1888.	1889.	Average.
Nitrogen,	91.2	72.5	81.8
Phosphoric Acid,	37.8	34.1	35.9
Potash,	48.2	57.7	52.9

The above are *average* figures designed to show the quantities of the ingredients named taken from the land by the ears and stover of a crop yielding 75 bushels of sound shelled corn per acre.

In the two years the *actual* yields of plots C and D were 141 bushels of shelled corn per acre, and the stover and shelled corn together took from an acre of land in these two crops the quantities of nitrogen, phosphoric acid and potash given below. There are also given the quantities of the same ingredients which were put on in the fertilizer during the two years.

	Nitrogen.	Phosphoric acid.	Potash.
Put on per acre in fertilizer during 2 years..	90.2	214.4	155.6
Taken off in crop " " ..	155 7	68.1	98.6
Gain, +, or loss, −, to the land	−65.5	+146.3	+57.0

It appears that the soil has been drawn upon for 65 pounds of nitrogen, four fifths as much as is required for a full crop of corn. At the same time it has been enriched by as much phosphoric acid as four crops would take from it and by as much potash as a single crop requires.

This is the result of using a fertilizer containing 4.5 per cent. of nitrogen, 10.7 of phosphoric acid and 7.8 per cent. of potash at the rate of 1000 pounds per acre, *without* stable manure. In 1889 the yield of corn on the rest of the farm was said by Mr. Gage to be larger and better than in 1888; but on these plots it was smaller. This is to be explained by a relative deficiency of nitrogen in the soil of the plots.

Evaporation of Water during Field-curing.

At the time of cutting, three samples were drawn on plot C. One weighing 75 pounds was taken to the laboratory and analyzed, another weighing 75½ pounds was placed in a cool dry room and allowed to cure till harvest time, a third weighing 83½ pounds was left in the stack.

By an oversight this last sample was not separately weighed when the crop was harvested so the data for determining the changes in the corn during field-curing are missing.

The per cent. of water contained in the crop on plot C, as determined at the time of cutting was 59.35 per cent., at harvest time it was 32.9 per cent. The total weight of crop at the time of *cutting* was 15,114 pounds per acre, and at *harvest* 9,156 pounds per acre. If now we assume that there was no loss of dry substance by fermentation or otherwise during the curing, the difference, 5,958 pounds, is the water which evaporated during field-curing, nearly 3 tons per acre.

That the crop did not suffer any great loss from fermentation during field-curing may be inferred from the following table which shows the composition of the dry matter in the crop, at the time of cutting, Sept., at the time of harvesting after field-curing, Oct., and thirdly, when house-cured as above described.

	September. When cut.	October. When field-cured.	October. When house-cured
Ash	3.4	3.4	3.1
Albuminoids	6.6	6.4	6.5
Fiber	19.0	19.4	19.2
Nitrogen-free Extract	67.8	67.7	68.0
Fat	3.2	3.1	3.2
	100.0	100.0	100.0

Any considerable loss by fermentation would have decreased the percentage of nitrogen-free extract, and correspondingly increased the percentages of the other ingredients.

Comparison of the Crops of 1888 and 1889.

This experiment in its main features is a confirmation of the previous experiment already described, and there is little to be added to the discussion and general statements made in connection with that experiment.

Some comparisons of the crops of 1888 and 1889 are instructive. The two crops were raised in the same field, the land was fertilized in exactly the same way and the crops were treated alike. The crop of 1888 followed sod, that of 1889 followed a flint corn crop in 1888. The rainfall for the whole year 1889 was far above the average, but not greater than that of 1888. During the growing season, however, from May first to November first, a good deal more rain fell in 1889 than in 1888. But again, less rain fell in 1889 during May, August, September and October than in 1888. But in July, 1889, there was an almost unprecedented rainfall, and from June on, the humidity of the air was considerably greater in 1889 than in the year before. June and July, 1888, were exceptionally dry months. 1889 was also a warmer year than 1888. The fall of 1888 was very unfavorable to field-curing, but in 1889, in this vicinity at least, there was less rain during September and October and warmer weather than in the previous year, and the crop cured much better in the stack.

Water in the crops.

What difference the weather during October may make in the cost of harvesting—as well as in the keeping of the gathered crop—may be seen in table XI. which shows the weight of water per acre for each distance of planting contained in the two crops of 1888 and 1889, after field-curing, *and reckoned to an equal production of dry matter in the two years.*

Table XI.—Water in the Field-cured Maize Crops of 1888 and 1889—Pounds per Acre.

Rate of planting.	Crop of 1888.	Crop of 1889.
One stalk in four feet	5380	2175
" " two "	6470	3552
" " to a foot	7888	3607
Two stalks " "	6930	4335
Four " " "	7964	5620
Eight " " "	8270	7608

The table shows that with the same yield of dry matter in the two years there would have been from 662 pounds to 4281

pounds more of water to be handled in 1888 than in 1889, or with the average rate of planting, one to two stalks to a foot in the row, about 1¾ tons more of water per acre in 1888 than in 1889.

With the average rate of planting, plots C and D, the field-cured crop of 1888 had 49.12 per cent. of water, that of 1889, 15 per cent. less, 34.1 per cent.

Proportion of shelled corn.

The crop of 1889 produced a larger proportion of kernels than that of the previous year by about 2 per cent. on the average of all the plots. On the three plots which had the thinnest stand the average yield of kernels in 1888 was 42.4 per cent. of the whole yield, and in 1889, was 48.8 per cent. (See table X.)

Percentage composition of the dry matter of the crops in 1888 *and* 1889.

a. Ash.—Excluding a single result in each year [from A in 1888 and F in 1889] which was so different from all the others as to suggest the possibility of error, the ash percentage in 1888 was between 3.12 and 3.29, in 1889 between 3.3 and 3.7 which is a rather close agreement.

b. Albuminoids.—In 1888 the percentage was very considerably higher than in 1889. The maximum, minimum and average percentages in the two years were as follows:

	Maximum.	Minimum.	Average.
In 1888	10.05	5.80	7.82
In 1889	8.70	5.60	6.70

c. Fiber.—On the two plots which were most thinly planted there was a slightly smaller percentage of fiber in 1889 than in 1888, on the other plots the reverse was the case.

d. Nitrogen-free Extract.—Variations were observed the reverse of those noted in the case of fiber. The crops of the *three* plots most thinly planted had a larger percentage of nitrogen-free extract in 1889 than in 1888, with the other plots the reverse was the case.

e. Fat.—Differences in the percentages for the two years are not marked.

Total Production of each Food Ingredient.

The crops on all the plots and the yield of each food ingredient as well, were very considerably smaller in 1889 than in 1888.

The falling off of the crop in 1889 is not in the same ratio on all the plots. If we call the yield in 1888 in each case 100 per cent. the several yields in 1889 expressed in per cent. will be as follows:

A, One stalk in four feet	50.8	per cent.
B, " " " two "	66.6	"
C, " " to a foot	83.6	"
D, Two stalks "	79.6	"
E, Four " "	79.9	"
F, Eight " "	71.2	"

From this it appears that, compared with the crop of 1888, the two plots A and B, which were most thinly planted, suffered most in 1889 from the changed conditions of soil, light, heat and moisture, and next to these the plot where the stand was thickest. As compared with 1888 there was in 1889, 20 per cent. less of mineral matter or "ash," 24 per cent. less fiber, 27 per cent. less fat and nitrogen-free extract and 37 per cent. less albuminoids.

The fact that grasses differ very greatly from year to year in the proportion of albuminoids, even when cut at the same period of development as nearly as can be, has been shown by observations at the New York Station; and that grasses cut here in 1889 were strikingly poorer in albuminoids than the same species cut from the same land at the same stage of growth in 1888 will appear further on in this Report. The maize plant, which is also a grass, has shown a like variation in these two years.

It is evident that in calculating rations by the aid of tables of the average composition of feeds great allowance has to be made for differences of water content and also for variations in the dry matter itself, particularly in the percentage of albuminoids which are the most costly element in feeds.

III.—Influence of the Size and Method of Cutting Seed Potatoes on the Crop and on the Variety.

A series of experiments was begun in 1889 on this subject which it was expected would be carried on for a term of years. The early appearance of the potato blight ruined some of the experiments and very seriously damaged all of them. It is thought best, therefore, to defer reporting any of the results till further data are secured.

IV.—Eastern and Western Sweet Seed Corn.

Small samples of seed were sent to the Station in the spring of 1889 by Mr. E. B. Clark of Milford, for comparison. They were labeled as follows:

A, Evergreen, J. C. Morgan, Mich.
B, " E. B. Clark, Conn.
C, " F. T. Emerson, Nebraska.
D, Early Crosby, C. S. Clark, Ohio.
E, " " E. B. Clark, Conn.

The weight of 100 kernels of the seed in grams was as follows:

A, 20.7 B, 26.7 C, 25.3 D, 19.5 E, 27.0

The corn was planted on May 17 in good soil, well fertilized. The drills were four feet apart and the kernels were about 18 inches apart in the drills. July 18th the following notes were made: Plot A, uneven stand, tips of tassels just showing; B, taller, even stand, tassels just showing; C, same as B; D, small, uneven stand, tasselled fully; E, tassels fully out, very thrifty. D and E have many suckers which are cut off.

Sept. 24. Topped the corn on all the plots. A has 159 stalks, 168 ears; B has 159 stalks, 158 ears; C has 44 stalks, 54 ears; D has 118 stalks, 147 ears; E has 203 stalks, 177 ears. B has decidedly larger and better ears than A. No apparent difference in ripeness between A and B. C looks decidedly inferior to A and B. The quantity of seed planted was not the same in the several plots, but it germinated about equally well on all the plots.

October 31. Harvested the corn. The average weight of dry corn on one ear was as follows:

A, 3.5 oz. B, 3.8 oz. C, 4.0 oz. D, 3.0 oz. E, 3.5 oz.

The dry matter of the kernels had the following composition:

			Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
A,	Evergreen,	Mich.	1.99	12.00	3.24	73.48	9.30
B,	"	Conn.	1.95	10.99	3.50	73.67	9.89
C,	"	Nebr.	2.28	12.19	3.12	72.83	9.58
D,	Early Crosby,	Ohio	1.88	13.88	2.54	71.86	9.84
E,	"	Conn.	2.07	14.60	2.67	70.74	9.92

GRASSES AND FORAGE.

Forage Plants of the Salt Marshes of Connecticut.

By A. L. Winton, Jr., Ph.B.

In 1884 the U. S. Department of Agriculture published a report on the tide marshes of the United States,* from which it appears that there are in Connecticut 34.79 square miles or 22,264 acres of "salt marsh" and 1.67 square miles or 1,069 acres of "swamp land" or fresh water tide marsh. We have been unable to ascertain what portions of this area lie in each of the several townships or counties which border on the sound and the larger rivers of the State. Through the kindness of Mr. A. B. Hill, city engineer of New Haven, we are however able to give the areas of marsh in and adjoining the town of New Haven, as follows :—

	Acres.
On easterly side of Harbor from Fort Hale to Grand Avenue Bridge	383
Quinnipiac River to North Haven or as far as salt marsh extends	3679
Mill River to Whitneyville Dam	434
West River salt marsh, below Congress Avenue	587
West River from Congress Avenue to Whalley Avenue	286
Total	5369

This does not include area of the rivers.

It appears that of the 23,300 acres of marsh, both salt and brackish, 5,369 or nearly one-fourth lie about New Haven.

The money value of the salt marshes in this State ranges from less than $10.00 per acre upwards according to the character of the land and its situation.

Care of the Marshes.—With the exception of a few acres of reclaimed marsh the only crop gathered from this large area is the so-called "salt hay" which varies greatly from place to place in the character of the herbage producing it, yields from one-half to two or more tons per acre and brings in market not more than from one-half to three-fourths as much per ton as upland hay. The marshes are neither manured nor tilled in any way by their owners. The only work spent on them besides harvesting the crop is making and maintaining the ditches and necessary bridges over the ditches and creeks. The sediment which settles from

* Miscellaneous Special Report No. 7, The Tide Marshes of the United States, by D. M. Nesbit, with contributions by the U. S. Coast and Geodetic Survey.

the water that overflows them during high tides, or, in the case of river marshes, during freshets, supplies the only fertilizer which they get and is a kind of natural sewage irrigation. The importance of ditching is well understood. On well ditched meadows the yield of hay is larger, and, owing to the firmness of the land, the crop is more easily harvested than on those where ditches are improperly constructed, neglected or wanting. Bare spots entirely devoid of vegetation, result from lack of care in keeping the ditches clear. The salt water remaining on the marshes after high tides and especially in a dry season, after concentrating by evaporation acts injuriously even on salt marsh plants.

Cutting and Curing the Hay.—The meadows are mowed anywhere from the middle of June to December. Although "Black-Grass," "Three-Square" and most of the other marsh plants, excepting, perhaps, "Red Salt Grass," yield a larger and better crop of hay the latter part of June or the first part of July than afterwards, still as a matter of fact few farmers cut salt hay till much later in the season. When the marshes are firm enough to bear it, the grass is cut with mowing machines. The horses' feet are often shod with "clods," which are stout pieces of board 7 by 9 inches square attached to their hoofs by means of irons fastened with bolts. Horses soon become accustomed to these clods and walk with little difficulty even on rather soft marsh. Generally it is practicable to cure the hay where it is cut, but where the meadows are so low as to be inundated at each tide it must be hauled to the upland for curing. Many hundred tons of the hay are annually stacked on the marshes. The latter plan is extensively practiced on the meadows about New Haven where each stack usually contains about a ton of hay and is raised a little above the marsh on a bunch of stakes driven into the ground.

Various Uses of the Hay.—The value of the hay for feeding varies greatly according to the kinds of plants which compose it as well as the time when it is cut. We have seen well-conditioned stock that have received none other than good salt marsh hay, while on the other hand some hay cut on the marshes is entirely unfit for feeding. The coarser kinds are only useful for litter and on some farms salt hay is used exclusively for this purpose. The hay from "Red Salt Grass" makes an excellent mulch which is particularly valued by strawberry growers, being quite free from any seeds which can prove troublesome. Salt hay is also largely used for packing crockery, etc.

THE VEGETATION ON THE MARSHES.—Directly adjoining the Sound and along the rivers where the water is distinctly salt, the vegetation differs materially from that further up the rivers and creeks where the tide-water rises daily but is only brackish, being mixed with fresh water.

We will separately consider the most important grasses, sedges, rushes and other plants of the salt marshes proper, and those growing more remote from the salt water on what may be called the brackish marshes. Following up our river valleys as far as tide-water rises, we generally find all stages of transition from purely salt marshes to brackish marshes and thence to fresh water river meadows.

A. *Plants growing on the salt marshes proper.*—Black Grass, (*Juncus Gerardi*), Salt Grass, "Red Salt Grass, "Fox Salt" etc., (*Spartina juncea*), and Creek Sedge, (*Spartina stricta*, var. *glabra*), make up most of the vegetation of the marshes, and of these salt grass is the most abundant. They do not grow mixed together so thoroughly as upland grasses and clovers but the marshes generally have a patched appearance. Sometimes these patches have only a few square feet of surface and sometimes they cover quite large tracts, but each patch is made up chiefly of one of the three above named species. Those of Black Grass show some shade of brown, those of Salt Grass and Low Creek Sedge are green and all are bordered on the creeks and ditches by Tall Creek Sedge. On marshes often overflowed with salt water Black Grass is generally wanting. Besides the plants already mentioned, more or less Goose Grass (*Triglochin maritimum*), Marsh Rosemary (*Statice limonium*, var. *Carolinianum*), and Sea Club Rush (*Scirpus maritimus*), are scattered through the marshes, and in places Spike Grass (*Distichlis maritima*), and some other plants occur.

B. *Plants growing on the brackish marshes.*—On these marshes there is greater variety of vegetation. Besides a few species peculiar to such localities, some of the plants described under A, and a number of fresh water grasses and sedges occur. Only the more common species are here noted. We find on the marshes whose level is little if any below that of high water mark, the sedges, "Three-Square" (*Scirpus pungens*), Larger Three-Square (*Scirpus Olneyi*), and "Snip Snap" (*Eleocharis rostellata*), the grasses, Fiorin (*Agrostis alba*), Red Fescue (*Festuca rubra*), Wild Rye Grass (*Elymus Virginicus*), and more or less Black

Grass with Wild Oats (*Zizania aquatica*), and Cord-Grass (*Spartina cynosuroides*), on the low borders adjoining rivers and ditches. In places there are acres of Cat Tails (*Typha latifolia*), and here and there a clump of *Phragmites communis*. On the very low marshes that most of the time are submerged, Wild Oats and Cord Grass flourish.

During the season of 1889 samples of most of these grasses, sedges, etc., were taken at different stages of growth from the meadows, and also samples of hay made from them. These were analyzed and the results appear in the tables on pages 243–245. A brief popular description of each plant is also given, which may help in recognizing them.

Black Grass (*Juncus Gerardi*).—The popular name "Black Grass" is a misnomer since the plant is not a grass at all but one of the rushes; a group of plants more nearly related to the lilies than to the grasses. Indeed the flowers of Black Grass somewhat resemble diminutive lilies.

While most of the marsh plants have received very appropriate names, the terms "grass," "sedge," and "rush" have naturally been used rather loosely. Black Grass commonly grows from one to two feet high, the fertile stalks rising from the roots and bearing at the summit the flowers (which afterwards develop into the little round pods) on the ends of short stems (peduncles.) It blooms early in June and gets its growth by about the first of July. If it is cut at that time the yield on a good marsh will be from one and one-half to two tons per acre of excellent hay which compares favorably with hay from upland meadows. The aftermath if cut about the first of September will yield from one-half to one ton per acre of hay equal or superior in feeding value to the first crop.

The fruit is ripe about the first of August, each little pod containing numerous minute seeds of which (as we have reckoned from actual weighing), it takes about 800,000 to make an ounce. In the table are given twelve analyses, five on samples from Saybrook, one from Guilford, two from Mill River and four from Quinnipiac River, both the latter localities near New Haven. In every case the earlier cut grass is the richer in albuminoids—the most valuable food ingredient.

Salt Grass (*Spartina juncea*), variously known in this State as Red Salt-Grass, Fox Salt Grass, etc., is a true grass and the most important, agriculturally, of the four species of Spartina that

grow on our salt marshes. It attains about the same height as Black Grass (one to two feet), but is readily distinguished from the latter by its later development, its leafy stems and by its flower-heads which are one to five in number, each about one inch long and quite one-sided. The stalks are tough and wiry and bear about six narrow rolled-up leaves alternately arranged.

Salt Grass hay is inferior to that of Black Grass, but is still a good fodder if used in connection with upland hay. It is useful as a mulch and is the kind of "salt hay" sought after by strawberry growers for this purpose. It generally brings in the market about half the price of upland hay. In the table are five analyses of this species taken at different stages of growth.

Creek Sedge (*Spartina stricta*, var. *glabra*).—This species, which is not a sedge but a true grass, when it grows on the banks of the creeks and ditches becomes coarse and rank, reaching a height of six or eight feet by the first of August, when it blooms. But when it grows away from creeks and ditches it is low and stunted seldom rising to a height of two feet even when in bloom. The leaves of Creek Sedge are broad and smooth and the edges are free from saw-teeth. The five to twelve heads or spikes are pressed close together along the flowering stalk making what appears to be a single slender head about one foot long. Each spikelet is one-sided like the salt grass. The stunted form when cut for hay is said to be relished by cattle and the same is true of the ranker growth if cut before it becomes coarse and woody, but if allowed to stand too long is only suitable for litter. Five analyses are given in the table.

Spike Grass (*Distichlis maritima*, or *Brizopyrum spicatum* of Gray's Manual) grows on the marshes but in less abundance than the plants already described. Its long root-stalk and deep seated roots fit it for the sandy shores where it is usually found. Like Salt Grass it has a wiry stalk with abundant leaves and grows to the height of one to two feet, but it differs in having a single head which is not one-sided. An analysis is given below.

Sea Club Rush (*Scirpus maritimus*), is a sedge about one foot high which is often found on the marshes and bears a close bunch of heads which, soon after bloom, has the size of a hickory nut. The seeds by the last of June are juicy and palatable. When cut before there is danger of the seed dropping it makes a nutritious hay. One analysis is given in the table.

Goose-Grass or Greasy-Bog (*Triglochin maritimum*). This plant with its round succulent leaves and its flower stalks one to

three feet high is widely distributed over the marshes. In early June it blossoms, and in the course of the summer ripens numerous oval fruit pods. Owing to its succulent nature it is seldom thoroughly dried in curing and feels greasy in the hay, hence the name Greasy-Bog. Two analyses are given below.

Three-Square (*Scirpus pungens*), is well described by its common name. The triangular stalk is from one to three feet high and near the summit bears the fruit heads in a close bunch. It is not peculiar to salt marshes, being very common on the borders of fresh-water rivers and ponds and in wet places generally. Many tons of Three-Square are cut annually for hay, and although rather coarse it has proved itself a valuable cattle food. Four analyses are given.

Larger Three-Square (*Scirpus Olneyi*), is a rarer plant but in places occurs in considerable abundance. A cross-section of a stem of Three-Square is sharply triangular, but a section of the Larger Three-Square is Y-shaped. See analysis.

Fiorin, (*Agrostis alba*). More or less Agrostis, generally a form like *A. alba*, grows luxuriantly near the ditches where the conditions are favorable for a thick stand. A method of handling the marshes so as to extend the growth of this most excellent grass would be welcome. Three analyses are given below.

Cord-Grass (*Spartina cynosuroides*). This coarse grass grows not only where the water is fresh or brackish but also, together with Creek Sedge, on muddy banks by the salt water. Before blooming it is readily distinguished from the latter by the rough saw-toothed edges of the leaves and afterwards by the spreading heads.

Snip-Snap, Two-Tail (*Eleocharis rostellata*). This, so far as we have observed, is the most common of several species of *Eleocharis* that grow on the marshes. The fertile plants consist of wiry stalks about a foot high with little oval heads on the summit, and remind one of large pins stuck in the turf. The sterile plants scattered among the latter bend over and take root at the apex of the leaf and appear like so many croquet wickets; hence the name "Two-Tail." As one walks through the marsh the feet catch in these wickets and they break with a snap—(Snip-Snap).

Wild-Rice (*Zizania aquatica*), also called Wild-Oats, Water-Oats, Blackbird-Oats and Indian Rice. This lordly grass growing from five to ten feet high is found on the river banks, often

covering acres of marsh, apparently doing best where at high tide it is partly or completely submerged. It has long broad leaves and a much branched panicle one to two feet long. The lower branches of the panicle are spreading and bear the staminate flowers while the upper branches are almost erect and bear the bearded fertile flowers. It blossoms in midsummer.

Wild-Oats is a nutritious grass and it is said that cattle relish it. As the seeds when ripe drop with the least touch, it should be cut before there is danger of losing them. At Essex, on the Connecticut river, there are acres of Wild-Oats which make, as is well known to sportsmen, a favorite feeding place for rail and other birds. In the Northwest the Indians are said to gather large quantities of the seed for food. See analyses below.

Wild-Rye-Grass (*Elymus Virginicus*), has a head much resembling Rye. Another species of Elymus occurs commonly in Connecticut but has not been noticed on the marshes.

Cat-Tail (*Typha latifolia*), which grows in the brackish marsh is never used for feed but makes a good bedding.

Notes on the Analyses and Conclusions.

It appears from the table of analyses that in every case any given species contains a higher percentage of albuminoids, the most costly food ingredient, and generally also of fat which is next in value, when cut before or at the time of bloom than when it is cut at a later period of development. The same is known to be true of the grasses on upland meadows and the fact harmonizes with the belief of some farmers that hay should be cut at the time of bloom on salt marshes as well as on upland. Red Salt Grass (*Spartina juncea*), blooms quite late, in the latter part of July or early in August, and if growing by itself might perhaps profitably be left till that late date. But Black Grass in particular yields the best return if cut early, and then a second and lighter cutting may also be got which is much richer both in albuminoids and fat. Compare analyses 10 and 11. In this vicinity, however, early cutting is the exception, and last year much of the grass stood till the middle of September.

The chief reason why the cutting of marsh hay is deferred so long is lack of time or help to secure it earlier. All upland hay is gathered first because it is generally considered to be superior. While it is not claimed that marsh hay is commonly as valuable as good upland hay, there is reason to believe that the best

marsh grasses are generally undervalued as forage and partly so because they are rarely cut until they are over-ripe, have dropped their seed and lost their flavor.

While chemical analysis does not accurately show the relative feeding value of different grasses—that depends on the digestibility and palatability of the food as well as on its composition—yet it gives valuable indications.

The following statement shows the average percentage composition of mixed Timothy and Red-Top, 10 analyses; mixed meadow grasses, 11 analyses; compared with Black Grass cut when seed was in the milk or before, 4 analyses; Salt Grass, 4 analyses; and Creek Sedge, 5 analyses, all reduced to a water-free basis:

	Timothy and Red-Top.	Mixed Meadow grasses.	Black Grass, *Juncus Gerardi.*	Red Salt Grass, *Spartina juncea.*	Creek Sedge, *Spartina stricta.*
Ash	5.5	5.5	7.9	9.3	11.7
Albuminoids	7.4	7.6	9.2	6.0	7.2
Fiber	34.4	35.6	29.0	28.6	29.4
Nitrogen-free Extract	50.4	48.9	51.3	53.4	49.5
Fat	2.3	2.4	2.6	2.7	2.2
	100.0	100.0	100.0	100.0	100.0

These figures show that when cut in proper season Creek Sedge has practically the same percentage of albuminoids and fat as good meadow hay with less fiber or woody tissue. Black Grass may have 1¾ per cent. more albuminoids, a little more fat, and considerably less woody fiber than these meadow grasses. Black Grass in blossom is quite as soft and fine as the best meadow hay and has a pleasant odor and flavor.

Certain other of the coarser grasses, as Creek Sedge, Indian Rice, Cord Grass, etc., especially the two first named, if cut while young may make quite palatable food.

Another point to be noted is this: that all the marsh grasses which are used for feed or litter bring no inconsiderable quantities of plant-food from the rivers and sea to the manure heaps.

Following are two tables of ash analyses of certain grasses which are the basis of subsequent calculations.

In making the analyses the determinations of potash, soda and chlorine were most carefully repeated and controlled and are believed to be quite exact. Taking the average of these determinations we find the following quantities, in pounds, of nitrogen,

Composition of the Ash of Salt-Marsh Plants.

	Black Grass. *Juncus Gerardi.*		Salt Grass. *Spartina juncea.*		Three-Square. *Scirpus pungens.*		Creek Sedge. *Spartina stricta.* var. *glabra.*
	June 22. No. 4.	Aug. 7. No. 9.	July 18. No. 15.	Aug. 5. No. 16.	June 22. No. 27.	Aug. 12. No. 28.	Aug. 5. No. 19.
Silica and Earth	7.03	12.05	32.73	*40.08	24.22	40.93	14.65
Oxide of Iron and Alumina	1.10	2.30	4.66	3.85	.89	.94	1.37
Lime	3.70	4.00	1.68	2.92	2.84	2.56	3.53
Magnesia	5.36	5.26	4.04	5.36	3.38	1.50	4.00
Potash	45.75	22.18	6.51	10.45	22.30	12.92	12.51
Soda	10.88	21.79	25.06	22.92	16.38	15.87	31.64
Sulphuric Acid	5.77	5.63	4.47	5.33	10.76	11.64	2.85
Phosphoric Acid	4.41	3.27	2.30	4.30	3.50	2.23	4.36
Chlorine	20.66	30.37	23.95	6.17	20.30	14.74	32.41
	104 66	106.85	105.40	101.38	104.57	103.33	107.32
Deduct Oxygen equivalent to Chlorine	4.66	6.85	5.40	1.38	4.57	3.33	7.32
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Per cent. of Ash in air-dry hay	5.80	7.01	12.19	5.78	8.59	8.56	8.48
Per cent. of salt in Ash reckoning soda as sodium chloride	20.50	41.09	47.25	43.20	30.87	29.90	59.64
Per cent. of salt in Ash reckoning chlorine as sodium chloride	34.09	50.11	39.52	10.18	33.50	24.32	53.48

Per Cent. of Nitrogen and Ash-Ingredients in the Hay of Salt-Marsh Plants.

	Black Grass. *Juncus Gerardi.*		Salt Grass. *Spartina juncea.*		Three-Square. *Scirpus pungens.*		Creek Sedge. *Spartina stricta.* var. *glabra.*
	June 22. No. 4.	Aug. 7. No. 9.	July 18. No. 15.	Aug. 5. No. 16.	June 22. No. 27.	Aug. 12. No. 28.	Aug. 5. No. 19.
Silica and Earth	.41	.84	3.99	2.31	2 07	3.49	1.24
Oxide of Iron and Alumina	.06	.16	.57	.22	.08	.08	.12
Lime	.21	.28	.21	.17	.24	.22	.31
Magnesia	.31	.37	.49	.31	.29	.13	.34
Potash	2.65	1.55	.79	.61	1.92	1.11	1.06
Soda	.63	1.53	3.06	1.32	1.41	1.36	2.68
Sulphuric Acid	.33	.40	.54	.31	.92	1.00	.24
Phosphoric Acid	.26	.23	.28	.25	.30	.19	.37
Chlorine	1.20	2.13	2.92	.36	1.75	1.26	2.74
	6.06	7.49	12.85	5.86	8.98	8.84	9.10
Deduct Oxygen equivalent to Chlorine	.26	.48	.66	.08	.39	.28	.62
	5.80	7.01	12.19	5.78	8.59	8 56	8.48
Nitrogen	1.19	1.18	1.04	.71	1.33	1.04	1.09
Probable per cent. of Salt (NaCl)	1.19	2.88	4.81	.59	2.65	2.08	4.55

* Of which 8.08 is silica soluble in dilute hydrochloric acid and 21.70 silica soluble in sodium carbonate solution.

phosphoric acid and potash in a ton of hay, of the kinds named, respectively.

	Black Grass.	Salt Grass.	Three Square.	Creek Sedge.
Nitrogen	23.8	17.4	23.8	21.8
Phosphoric Acid..	5.0	5.4	5.0	7.4
Potash	42.0	14.0	30.2	21.2

Five tons of this hay contains as much of these fertilizing materials as are contained in a full crop of corn, including stover, from an acre of land.

It may be here remarked that the samples, as is usual with salt marsh hay, were more or less coated with mud and salt so that the quantities of silica and earth and of salt given in the analyses are larger than existed as actual constituents of the plants. Analyses of the clean plants would be of scientific interest but it was our object to ascertain the composition of the plants as cut in farm practice.

The percentage of adhering matters is extremely variable, depending on the situation of growth, the washing and spattering of rains and the overflowing of tides.

In the seven samples of which the analyses of the ash are given above the quantity of salt in a ton of hay varied from 12 to 90 pounds, the average being 54 pounds.

The question of reclaiming salt marsh and growing other farm crops on it need not here be discussed. It is believed that by proper ditching and earlier cutting our marshes may be made a good deal more profitable without changing the kind of vegetation now growing on them.

Analyses of Grasses and other Forage Plants growing on Tide Marshes.

Number.	Name.	Locality.	Date of Cutting.	Stage of Growth.	Analyses.						Analyses, Calculated Water-free.				
					Water.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract. Starch, Gum, etc.	Fat.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract. Starch, Gum, etc.	Fat.
1	Black Grass.		1888.												
	Juncus Gerardi.	Saybrook.	July 1		6.74	6.61	8.62	27.74	48.14	2.15	7.08	9.24	29.76	51.62	2.30
2	" "	"	Sept. 1		6.74	9.18	6.56	26.16	49.13	2.23	9.84	7 03	28.06	52.68	2.39
			1889.												
3	" "	"	June 22	In bloom.	8.15	7.96	9.20	25.37	46.61	2.71	8.68	10.02	27.64	50.71	2.95
4	" "	"	22	Seed in milk.	10.04	5.80	7.44	27.40	46.93	2.39	6.44	8.26	30.44	52.20	2.66
5	" "	"	Aug. 12	Seeds gone.	7.35	4.97	5.31	28.20	52.09	2.08	5.37	5.73	30.46	56.20	2.24
6	" "	Mill River Marsh, New Haven.	June 30	Seed in milk.	10.58	8.71	8.12	25.06	45.21	2.32	9.74	9.08	28.03	50.56	2.59
7	" "	" " "	Sept. 27	Aftermath.	8.99	9.22	7.50	23.43	47.78	3.08	10.13	8.25	25.75	52.49	3.38
8	" "	Quinnipiac Marsh, New Haven.	July 20	Seed almost ripe.	9.94	7.93	7.75	24.10	47.38	2.90	8.80	8.60	26.74	52.64	3.22
9	" "	" " "	Aug. 7	Seed very ripe.	9.51	7.01	7.37	24.41	48.84	2.86	7.74	8.15	26.97	53.98	3.16
10	" "	" " "	Sept. 15	Seed gone.*	11.49	5.37	6.69	26.36	47.23	2.86	6.07	7.56	29.79	53.36	3.22
11	" "	" " "	15	Second growth.†	11.63	8.78	11.62	20.44	44.32	3.21	9.94	13.14	23.12	50.17	3.63
12	" "	Guilford.			9.60	6.09	8.00	27.21	46.83	2.27	6.74	8.84	30.10	51.81	2.51
13	Red Salt Grass.														
	Spartina juncea.	Saybrook.	1888.		6.74	9.00	4.50	24.30	53.22	2.24	9.65	4.82	26.04	57.09	2.40
			1889.												
14	" "	"	June 22	Spikes not visible.‡	10.10	7.02	6.37	26.80	47.08	2.63	7.80	7.08	29.81	52.39	2.92
15	" "	Quinnipiac Marsh, New Haven.	July 13	In bloom.	9.22	12.19	6.50	26.14	43.64	2.31	13 43	7.15	28.79	48.09	2.54
16	" "	" " "	Aug. 5	In seed.	9.01	5.78	4.44	27.18	51.09	2.50	6.35	4.88	29.87	56.15	2.75
17	" "	" " "	Sept. 14	Seed gone.	8.15	5.08	4.13	26.72	53.17	2.75	5.54	4.49	29.11	57.87	2.99

* Grass dried and brown. † Grew up through the lodged first growth. ‡ Growth thick but low.

Analyses of Grasses and other Forage Plants growing on Tide Marshes—*Continued.*

Number.	Name.	Locality.	Date of Cutting.	Stage of Growth.	Analyses.						Analyses, Calculated Water-free.				
					Water.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract. Starch, Gum, etc.	Fat.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract. Starch, Gum, etc.	Fat.
18	Creek Sedge.		1889.												
	Spartina stricta var. *glabra.*	Quinnipiac Marsh, New Haven.	July 5	Spikes not visible.	9.72	15.30	8.44	25.53	39.02	1.99	16.95	9.35	28.28	43.21	2.21
19	" "	" " "	Aug. 5	In bloom.	8.18	8.48	6.81	26.72	47.75	2.06	9.24	7.42	29.10	51.00	2.24
20	" "	Saybrook.	12	In bloom.*	7.37	8.33	4.00	27.28	51.25	1.77	9.00	4.32	29.46	55.31	1.91
21	" "	"	12	" †	8.13	11.85	6.06	27.70	44.02	2.24	12.87	6.58	30.14	47.98	2.43
22	" "	"	12	" ‡	8.25	9.66	7.62	27.39	44.90	2.18	10.52	8.30	29 83	48.98	2.37
23	Spike Grass.¶														
	Distichlis maritima.	Stratford.	31	"	9.22	6.99	5.44	26.38	49.42	2.55	7.70	5.99	29.05	54.46	2.80
24	Sea Club Rush.														
	Scirpus maritimus.	Saybrook.	June 22	Soon after bloom.	11.24	7.98	9.19	24.75	43.99	2.85	8.98	10.36	27.84	49.62	3.20
25	Goose Grass.														
	Triglochin maritimum.	"	22	Seed soft.§	7.16	10 98	11.37	25.13	42.01	3.35	11.84	12.25	27.08	45.23	3.60
26	" "	New Haven.	July 13	" ‖	9.02	6.29	8.12	36.31	37.57	2.69	6.92	8.93	39.90	41.29	2.96
27	Three Square.														
	Scirpus pungens.	Saybrook.	June 22	Soon after bloom.	7.97	8.59	8.31	25.10	47.41	2.62	9.34	9.02	27.29	51.50	2.85
28	" "	"	Aug. 12	Seed dropping.	7.89	8.56	6.50	23.76	50.49	2.80	9.29	7.06	25.78	54.83	3.04
29	" "	Quinnipiac Marsh, New Haven.	July 13	Seed hard.	8.00	8.22	7.44	30.22	43.97	2.15	8.94	8.08	32.85	47.79	2.34
30	" "	Mill River Marsh, New Haven.	Aug. 5	Seed gone.	8.55	7.89	7.37	23.68	49.95	2.56	8.63	8.06	25.88	54.63	2.80

* Banks of a creek of brackish water, 6 feet high.
† Banks of a creek of salt water, 6 feet high.
‡ Near 20 and 21, but in the middle of the marsh, 1 foot high.
§ Leaves only.
‖ Stalks with green seed pods.
¶ *Brizopyrum spicatum* of Gray's Manual.

ANALYSES OF GRASSES AND OTHER FORAGE PLANTS GROWING ON TIDE MARSHES—*Continued.*

Number.	Name.	Locality.	Date of Cutting.	Stage of Growth.	Analyses.						Analyses, Calculated Water-free.				
					Water.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract. Starch, Gum, etc.	Fat.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract. Starch, Gum, etc.	Fat.
31	Larger Three Square.		1889.												
	Scirpus Olneyi.	Quinnipiac Marsh, New Haven.	July 28	Soon after bloom.	9.53	8.24	10.06	25.14	45.25	1.78	9.11	11.12	27.79	50.01	1.97
32	White Bent or Fiorin.														
	Agrostis alba.	Saybrook.	June 22	Before bloom.	7.68	6.73	9.38	26.47	47.48	2.26	7.28	10.18	28.68	51.41	2.45
33	" "	"	Aug. 12	Seed gone.	6.83	4.92	5.19	27.53	53.92	1.61	5.28	5.57	29.55	57.87	1.73
34	" "	Quinnipiac Marsh, New Haven.	June 28	In bloom.	9.08	8.64	8.69	24.48	46.65	2.46	9.52	9.57	26.94	51.28	2.69
35	Fresh-water Cord Grass.														
	Spartina cynosuroides.	New Haven.*	Aug. 5	"	8.16	6.18	5.62	30.79	47.43	1.82	6.74	6.12	33.54	51.62	1.98
36	Snip Snap or Two Tail.														
	Eleocharis rostellata.	Saybrook.	June 22	Soon after bloom.	8.67	9.47	9.32	24.61	45.51	2.42	10.37	10.21	26.96	49.81	2.65
37	" "	"	Aug. 12	Seed hard.	8.09	10.72	8.25	24.25	46.29	2.40	11.66	8.97	26.39	50.37	2.61
38	Wild Rice or Wild Oats.														
	Zizania aquatica.	New Haven.†	July 13	Coming into bloom.	9.86	16.95	8.56	25.44	36.28	2.91	18.80	9.50	28.23	40.24	3.23
39	" "	" †	Aug. 5	In bloom.	8.23	14.25	7.12	31.06	37.29	2.05	15.52	7.76	33.84	40.65	2.23
40	Wild Rye Grass.														
	Elymus Virginicus.	"	June 28	Before bloom.‡	6.87	7.09	7.62	32.01	44.36	2.05	7.62	8.18	34.37	47.53	2.20
41	Cat Tails.														
	Typha latifolia.	"	July 13	§	10.77	5.78	7.00	33.68	39.75	3.02	6.37	7.85	37.76	44.64	3.38

* Banks of Mill River. † In shallow water. ‡ 3 feet high. § Leaves only.

COMPARISON OF THE YIELD AND COMPOSITION OF CERTAIN GRASSES IN 1888 AND 1889.

By E. H. Jenkins.

In the Report for 1888, page 100, are described in detail certain plots of grass, each containing only a single species, from which the crops are to be annually gathered, each at the period of full bloom, weighed and analyzed. The weights and analyses of the crops for 1888 are also given in the Report for that year, p. 101.

In the early spring of 1889, as in the previous year, the dead aftermath grass was burned off, and a fertilizer made up of 150 pounds of nitrate of soda, 250 pounds tankage, 30 pounds muriate of potash and 125 pounds dissolved bone black was sown over the whole garden at the rate of 555 pounds to the acre. The same had been done the year before. The crop on each plot was cut at the time of full bloom as nearly as was possible. The continuous rains in June made it difficult to determine in all cases just when the grass was fully in bloom and also hindered in the cutting and weighing. It is believed that all the grasses were cut at a period a trifle more advanced than last year, but the difference was not great.

The following table contains the results obtained in 1889:

Name of Grass.	Plot.		Per cent. Nitrogen. Total.	Albuminoid.	Per cent. of Phosphoric Acid.	Per cent. of Potash.
Tall Red Top	E	Fresh.	.34	.29	.18	.72
		Water-free.	.79	.67	.43	1.68
Fine Bent	D	Fresh.	.43	.37	.21	.78
		Water-free.	1.06	.92	.52	1.94
June-grass	A	Fresh.	.39	.32	.18	.78
		Water-free.	1.18	1.00	.56	2.42
Wood Meadow-grass	C	Fresh.	.37	.36	.15	.74
		Water-free.	1.11	1.04	.45	2.21
Orchard-grass	I	Fresh.	.30	.26	.15	.79
		Water-free.	1.02	.86	.50	2.61
Tall Oat-grass	Z	Fresh.	.28	.21	.14	.76
		Water-free.	1.02	.77	.53	2.82
Yellow Oat-grass	Q	Fresh:	.30	.26	.13	.66
		Water-free.	1.02	.91	.46	2.31
Meadow Fescue	Y	Fresh.	.29	.24	.14	.62
		Water-free.	1.10	.91	.53	2.38
Sweet Vernal-grass	S	Fresh.	.37	.32	.16	.63
		Water-free.	1.42	1.26	.62	2.46

No extended discussion is desirable till further data can be presented.

The leading facts which appear from a comparison of the crops of 1888 and 1889 are these :

1. The weight of the water-free crops on three plots, D, E and Y, was less in 1889 than in 1888; but on the other six plots it was larger and the gross yield from them all was 7 per cent. larger in 1889 than in 1888.

2. In the water-free crops the percentage of ash did not exhibit very striking differences in the two years. The per cent. of fiber and of nitrogen-free extract was on the average considerably larger in 1889 than in 1888. The percentage of fat was smaller. Very striking, however, are the differences in albuminoids. In 1889 there was on the average, in the dry matter of these grasses 28 per cent. less albuminoids than in 1888. The minimum difference was 16 per cent., the maximum difference 40 per cent.

A similar though not so striking a difference in the percentage of albuminoids has already been noticed in the corn crops of the two years; see page 230.

This striking decrease of nitrogen in the crop of 1889 is to be explained by the facts that the fertilizer applied did not furnish nearly enough nitrogen to meet the requirements of the crop, and that nitrogen is known to be relatively deficient in our soil.

ON THE AWNED SEED OF AGROSTIS VULGARIS.

By E. H. Jenkins.

The species *Agrostis vulgaris* has at least two very distinct agricultural varieties well known to farmers in the eastern states and very likely elsewhere; one is the coarse red top, called by Gould *A. vulgàris, major*, the other, *A. vulgaris minor*, variously called fine bent, furze-top and Rhode Island bent. A popular description of these varieties by J. B. Olcott may be found in the Report of this Station for 1887, page 177.

Awns on the palets of coarse red-top are unknown, but in old pastures where fine bent grows abundantly, plants with awned palets are occasionally found. The awns are upwardly barbed, usually geniculate, attached very near the base of the palet. The plants which bear them do not differ strikingly in appearance from the others which are not awned.

An experiment was begun in 1888 to learn whether awned seed produces plants bearing *only* awned seed or a *larger proportion* of

Analyses of Grasses grown in 1889.

Name of Grass.	Plot.	When cut.	Average height of flower stalks in inches.	Weight of Crop in ounces.		Composition of the Crop. Per cent.				
					Water.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Crude Fat.
Tall Red-top. *Agrostis vulgaris, major*	E	June —	36	Fresh, 277	57.29	2.24	2.12	15.74	21.64	.97
				Water-free, 118		5.24	4.96	36.89	50.63	2.28
Fine Bent. *Agrostis vulgaris, minor*	D	—	26	Fresh, 186	59.71	2.93	2.67	13.29	20.51	.89
				Water-free, 75		7.28	6.64	33.00	50.88	2.20
June-grass. *Poa pratensis*	A	" 10	30	Fresh, 240	67.02	2.07	2.44	10.77	16.77	.93
				Water-free, 79		6.29	7.38	32.64	50.86	2.83
Wood Meadow-grass. *Poa nemoralis*	C	—	26	Fresh, 216	66.57	1.67	2.32	11.62	17.03	.79
				Water-free, 72		4.98	6.91	34.77	50.97	2.37
Orchard-grass. *Dactylis glomerata*	I	" 10	48	Fresh, 408	69.86	1.75	1.92	11.11	14.55	.81
				Water-free, 123		5.79	6.36	36.92	48.23	2.70
Tall Oat-grass. *Arrhenatherum avenaceum*	Z	" 10	60	Fresh, 400	72.62	1.60	1.74	9.70	13.73	.61
				Water-free, 109		5.84	6.35	35.47	50.11	2.23
Yellow Oat-grass. *Avena flavescens*	Q	—	40	Fresh, 292	70.11	1.71	1.91	10.06	15.46	.74
				Water-free, 87		5.74	6.40	33.67	51.70	2.49
Meadow Fescue. *Festuca pratensis*	Y	—	43	Fresh, 268	73.18	1.58	1.84	10.19	12.55	.66
				Water-free, 72		5.90	6.86	38.02	46.73	2.49
Sweet Vernal-grass. *Anthoxanthum odoratum*	S	" 10	25	Fresh, 196	74.41	1.55	2.29	7.68	13.10	.97
				Water-free, 50		6.06	8.93	30.00	51.22	3.79

awned seed than is produced by plants grown from seed destitute of awns.

A small lot of furze-top hay containing some awned seed was kindly sent to the Station by Mr. Charles Potter of Prudence Island, Providence, R. I., who makes a specialty of raising fine-bent seed. Seeds were picked from this sample and each one was separately examined to be sure that it was awned. These were planted on clean land in the spring of 1888, and made a good growth the first year, but did not blossom.

In 1889 the plants seeded fully. The whole crop was cut when the seed was ripe and each panicle was separately examined for awns. The results were as follows:

	No. of panicles fully awned.	No. of panicles with few awns.	No. of panicles with no awns.
Stool No. 1	9	0	0
" " 2	0	29	1
" " 3	35	6	5
" " 4	56	36	0
" " 5	191	18	0
" " 6	116	0	0
" " 7	52	15	0
" " 8	2	63	0
" " 9	4	41	0
	465	208	6

The panicles described as fully awned may have had a few seeds destitute of awns.

Comment on the results is reserved till further data have been gathered.

COMPARISON OF SOLVENTS FOR FAT IN FEEDING STUFFS.

By R. S. Curtiss, Ph.B.

The following experiments were made to compare ether, petroleum-benzine and chloroform in their action on feeding stuffs, particularly with reference to chlorophyl, which it has been claimed is not dissolved by petroleum-benzine. On this ground it has been proposed to substitute benzine for ether in the determination of fat. The ether here employed was purified and dried by standing over fused $CaCl_2$ for twenty-four hours or more with frequent shaking. It was then distilled from $CaCl_2$ on a water-bath. From the petroleum-benzine, which is known in trade as 76° B, two fractions were prepared. The fraction distilling from 53°–60° C. was redistilled and the portion coming off from this between 55°–60° C. was used in the experiments. Likewise the portion obtained in the first distillation from 63°–80° C. was redistilled and the fraction coming off at 75°–80° C. reserved for use. A third preparation was made from what is known as 80°–90° gasoline. This material has a nauseating odor which made it necessary to boil off the more volatile portions in the open air. The fraction distilling off between 45° and 50° C. was used in the experiments.

The chloroform operated with was Malinckrodt's, thoroughly dried over $CaCl_2$ and distilled. Its boiling point was between 60.5° and 61.5° C.

For comparing these solvents six substances were selected, viz :

No. 4, *Typha latifolia*, the common cat-tail.

No. 10, *Agrostis alba*, a meadow grass.

No. 38, *Juncus Gerardi*, a sedge cut late.

No. 39, *Juncus Gerardi*, the young aftermath.

No. 2662, Linseed meal, new process.

No. 2664, Gluten meal.

These samples, air dried when necessary, were finely ground. In all cases the extractions were made in duplicate on 2 grams of material, previously dried at 100° C. to constant weight, in a current of hydrogen. The extractions were carried on at or near the boiling points of the solvents, in the apparatus for continuous extraction, first described by the Director of this Station in 1875, and figured in the American Journal of Science for March, 1877,

p. 196. When the extraction was interrupted as at night, the residues were protected from the possible absorption of moisture. The flasks containing the extracts were finally heated for three hours in an air-bath at 100° C., to remove the solvent, care being taken to displace all heavy vapors from the flasks during the drying. They were then allowed to cool in the air and weighed with counterpoise-flasks. The table on the following page shows the percentage of matter extracted from each of the materials, and the accompanying notes give further details regarding the action of the various solvents.

Ether.

On five of the samples single extractions were made, continuing for three hours, previous experiments having proved that this length of time was sufficient except with No. 39, which required more than eleven hours treatment for perfect extraction and even then the residue retained a distinct dark green color.

Another portion of No. 39 extracted continuously for eight hours, yielded 3.21 per cent., three hours additional treatment gave .31 per cent., and a third extraction yielded .07 per cent., making the total extract 3.59 per cent.

Gasoline distilled at 45°–50° C.

The first extraction lasting three hours, removed from linseed and gluten meal all which the solvent could take up. In all cases the extraction was complete in six hours. Chlorophyl appeared to be removed from the other samples as fully as by the use of ether.

Petroleum-benzine distilled at 55°–60° C.

The first extraction lasting three hours apparently removed all the chlorophyl of samples No. 4 and No. 38, while No. 39 still had a decided dark green color even after the second treatment. Except in two cases the extraction was practically complete at the end of three hours.

Petroleum-benzine distilled at 75°–80° C.

The extractions were nearly complete in three hours. The action on the coloring matter was apparently the same as noted in case of the other grades of benzine.

Extract, in Per cent. of Air-dry Material.

	First extraction, 3 hours.						Second extraction, 3 hours additional.¶					
	4	10	38	39	2662	2664	4	10	38	39	2662	2664
Ether	3.02	2.46	2.86	2.94*	2.63	16.11	....	....	....	....	....	....
Petroleum-benzine, 45°–50°	1.59	1.85	1.82	2.03	....	....	.12	.10	.14	.15	....	....
" " 55°–60°	2.07	....	2.09†	2.53	2.27	15.81	.09	....	.02	.09‡	.30	.18
" " 75°–80°	2.50	2.45	2.24	2.73	2.60	15.91	.04	.12	.08	.11	.20	.21
Chloroform	3.54§	3.55	3.40	3.75	....	....	.35‖	.26	.22	.38	....	....

* Difference between duplicates = 0.26 per cent.
† " " " = 0.14 "
‡ " " " = 0.19 "
§ " " " = 0.15 "
‖ " " " = 0.25 "
In all other cases the duplicate agreed to within 0.1 per cent.
¶ Second extraction with benzine, 55°–60° lasted 4½ hours.

Chloroform.

Six repetitions of the first extraction, fresh chloroform being used each time, were necessary to completely exhaust the samples.

TOTAL EXTRACT.

The total quantity of extract obtained with each solvent is given below in per cent. of air-dry substance.

	No. 4	No. 10	No. 38	No. 39	No. 2662	No. 2664
Ether	3.02	2.46	2.86	3.59	2.63	16.11
Petroleum dist. at 45°–50°	1.71	1.95	1.96	2.18	....	....
" " 55°–60°	2.16	....	2.11	2.62	2.57	16.05
" " 75°–80°	2.54	2.57	2.32	2.84	2.80	16.13
Chloroform	5.23*	4.78	4.21	5.57†	....	....

As was to be anticipated it is very difficult to remove the last portions of petroleum-benzine from the extracts before weighing. This solvent is a mixture of a large number of different hydrocarbons having widely different boiling points. The lighter portions on heating pass off with ease, but the heavier are held very obstinately by the extract so that to perfectly remove them probably requires a higher temperature than 100° C. and involves danger of decomposing the extracts themselves.

It appears from these results that petroleum-benzine and chloroform dissolve chlorophyl quite as readily as ether. In all cases but one, benzine extracted considerably less than ether, but it has yet to be shown that the benzine-extract any more nearly represents true fat than the ether-extract.

Petroleum-benzine is also especially unfit for use as a solvent in quantitative work for the reason that it is an indefinite and variable mixture of a number of solvents, which, as the above results indicate, have different solvent action on the dry matter of feeding stuffs.

* Disagreement between duplicate determinations = 1.06 p. c.
† " " " " = 0.20 "

THE DETERMINATION OF PHOSPHORIC ACID IN FERTILIZERS BY THE "CITRATE METHOD."

By S. W. Johnson and T. B. Osborne.

In the Report of this Station for 1880, page 103, are references to the literature of this subject previous to that date, and a detailed account of experiments, made by Mr. H. L. Wells,* at this Station, with the object of learning the sources of error in the "Citrate Method" of determining phosphoric acid. The summary of Prof. Wells' laborious and skillful research, involving 140 determinations of phosphoric acid, is as follows:

"The conditions which tend to introduce a plus error are these:

1. Excessive amount of magnesia mixture in the presence of citric acid.
2. Presence of calcium as sulphate or chloride.
3. Presence of ferric salts.

The circumstances which tend to make a minus error are:

1. Solvent action of ammonium citrate on $MgNH_4PO_4$.
2. Presence of aluminium salts in the solution.

The most serious error is likely to come from the solvent action of ammonium citrate, and it is to be avoided by increasing the amount of magnesia mixture as the amount of citrate increases, by moderate dilution, and when the amount of citrate is very large [23 grams as in the case of reverted P_2O_5 estimations] by increasing the amount of ammonia employed. In case of most fertilizers the presence of calcium salts nearly or entirely compensates for the solvent effect of the citrate."

The following quantities of reagents were used in the analyses of commercial fertilizers made by Mr. Wells.

"1. Bones and natural phosphates [20–30 per cent. P_2O_5]. Use 1 gram substance, 10–15 grams $\overline{Ci}$, 30–40 c. c. Mg. mixture, 350–400 c. c. solution, of which one quarter is ammonia of specific gravity 0.96.

2. Superphosphates, soluble P_2O_5, 1–2 grams substance, 5–10 grams $\overline{Ci}$, 20–30 c. c. Mg. mixture, 350 c. c. solution.

Reverted P_2O_5, 1–2 grams substance, $11\frac{1}{2}$ or 23 grams $\overline{Ci}$, 40 c. c. Mg. mixture, and more ammonia than usual.

Insoluble P_2O_5, 2 grams substance, $\overline{Ci}$, etc., same as soluble."

Direct determinations of total phosphoric acid were made in

* Now Assistant Professor of Analytical Chemistry in Yale University.

thirty-eight commercial fertilizers of all the kinds then in our market, both by the molybdic and by the citrate methods.

In 14 of these cases the citrate method and in 19 the molybdic method gave the higher result. In 5 instances the results by the two methods were identical. In 5 cases the disagreement amounted to 0.2 per cent. or more; the differences being respectively 0.22, 0.31, 0.36, 0.40, and 0.42. The *average* difference between the two methods was 0.11.

In six comparative determinations of soluble phosphoric acid, the citrate method in all cases gave lower results than the molybdic method. The greatest difference was 0.30, the average difference, 0.13.

Since then the citrate method has been studied by others who appear to have generally overlooked Wells' work and to have repeated much of it with essentially the same results.* The fact that foreign chemists are now using this method is the occasion of giving it a more extended investigation. Wells was led to vary the conditions under which his determinations were made, according to the nature of the phosphate under examination. The volume of the solution in which ammonium magnesium phosphate was precipitated, for example, varied from 350 to 400 c. c. and the quantity of citric acid from 5 to 11½ grams. We have, on the contrary, endeavored to keep the conditions as nearly constant as possible in the following analyses.

Several determinations were first made nearly following a method described by J. H. Vogel (Chemiker Zeitung, Vol. XII, p. 86) as follows: "To 50 c. c. of a solution containing 0.5 gram of the phosphate are added 10 c. c. of a 50 per cent. solution of citric acid and after neutralizing with ammonia, 20 c. c. of magnesia-mixture and 10 or 12 c. c. of strong ammonia water, the solution being vigorously stirred. After standing two hours the precipitate is filtered off, ignited and weighed."

For the convenience of using the solutions at hand in the Station laboratory that had been prepared for the routine work of fertilizer analysis, the method as given by Vogel was varied by taking in case of soluble phosphoric acid, 0.4 grams of substance, and by using in all cases 100 c. c. of the solution of the material analyzed. Further the magnesia-mixture here employed contains twice as much ammonium chloride in the liter as that

* Reference to recent literature is given in Zeitschr. für angew. Chemie, 1889, 702.

proposed by Märcker and used by the German chemists, its proportions otherwise being the same.

Below the composition of the two mixtures is contrasted:

MAGNESIA-MIXTURES.

	German Experiment Stations.	United States Experiment Stations.
$MgCl_2 6H_2O$	110 gm.	110 gm.
NH_4Cl	140 "	280 "
NH_3, sp. gr. .96	700 c. c.	700 c. c.
H_2O	1300 "	1300 "
Volume	2000 "	2000 "

Following are the per cent. results obtained compared with those by the molybdic method:

TOTAL PHOSPHORIC ACID.

Station Number.	Determined by the Citrate Method.	Molybdate Method.	Difference.
2314	11.19	11.26	— .07
2324	12.33	12.54	— .21
2328	11.14	11.13	+ .01
2377	9.68	9.94	— .26
2382	10.53	10.50	+ .03
2392	8.37	8.57	— .20

SOLUBLE PHOSPHORIC ACID.

2314	8.11	8.44	— .33
2318	6.69	6.88	— .19
2324	7.60	8.06	— .46
2328	4.68	5.09	— .41
2377	4.16	4.34	— .18
2392	7.54	7.57	— .03

The citrate method, it is seen, gave generally a less amount than the molybdic, the average deficiency being about .20 and the greatest .46. The deficiency is greatest with soluble phosphoric acid.

The following modification of the method was then tried and in most cases the results proved to be satisfactory. The volume of the solution of the phosphate was in all cases 100 c. c. and this was mixed with 10 c. c. of a 50 per cent. solution of citric acid. After neutralizing with ammonia, 50 c. c. of U. S. magnesia-mixture was slowly added with constant stirring and when the precipitate had separated, 30 c. c. of concentrated ammonia water

was poured in. After two hours the precipitate was filtered on a Gooch crucible, ignited and weighed. If the sample analyzed had more than 10 per cent. of phosphoric acid one gram of it was commonly used for the determination. If less than 10 per cent., two grams were usually employed. In the case of ashes containing soluble silica this substance was first separated.

The percentages, or their averages, thus obtained on a variety of materials are shown in the following Table, compared with the figures got by the molybdate method. Certain phosphates, as Thomas Slag and Keystone Concentrated Phosphate, containing much iron or aluminium failed to be precipitated sufficiently and with them satisfactory results were in no case secured. They are not included in the table:

BONE.

Station Number.	Phosphoric Acid. By Citrate method.	Phosphoric Acid. By Molybdate method.	The Citrate method gave more (+), or less (−), than the Molybdate method.
2362.....	23.57—23.51	23.50—	+ .04
2364.....	21.49—21.50	21.43—21.49	+ .03
2369.....	18.40—18.43	18.37—18.59	— .06
2424.....	27.40—27.59	27.50—27.87	— .18
2426.....	21.74	21.82	— .08
2430.....	21.49	21.44—21.39	— .07
2431.....	21.98	21.82	+ .16
2435.....	25.79	25.61	+ .18
2436.....	22.82	22.78	+ .04
2440.....	23.00—23.16	22.99	+ .09
2441.....	21.41	22.41—22.31	+ .05
2452.....	18.26—18.29	18 58—18.52	— .27
2614.....	18.52	18.50	+ .02

BONE AND CHEMICALS.

2412.....	20.93—21.02	20.94—21.02	.00
2432.....	15.67	15.81	— .14
2433.....	14.57	14.69	— .12

SUPERPHOSPHATES.

Total P_2O_5.

No. 2....	14.84	14.80	+ .04
No. 3....	10.51	10.61	— .10
2394.....	10.44—10.46	10.44—10.50	— .02
2415.....	11.85	12.20	+ .35
2428.....	17.06	16.95	+ .11
2447.....19.23—19.29—19.37		18.96—19.04	+ .33
2451.....	15.85	15.76	+ .11
2455.....	8.78	8.81	— .03
2456.....	12.64—12.72	12.22—12.32	+ .41

Station Number.	Phosphoric Acid. By Citrate method.	Phosphoric Acid. By Molybdate method.	The Citrate method gave more (+), or less (−), than the Molybdate method.
2457	8.76	8.83	− .07
2458	11.67	11.68	− .01
2608	10.59	10.61—10.75	− .09
2613	7.94	8.02	− .08
2615	8.93	9.02—9.12	− .14
2616	8.49	8.57	− .08
2617	6.50	6.52	− .02
	Soluble P_2O_5.		
No. 3	6.85	6.83	+ .02
2394	8.62	8.59	+ .03
2428	16.90	16.99	− .09
2447	13.39	13.26	+ .13
2451	15.46	15.59	− .13
2608	7.60	7.55	+ .05
2613	6.74	6.77	− .03
2615	6.94	6.96	− .02
2616	6.35	6.40	− .05
2617	5.42	5.65	− .23
	Insoluble P_2O_5.		
No. 2	1.46	1.45	+ .01
No. 3	1.62	1.67	− .05
2394	.68	.65	+ .03
2415	3.78	3.65—3.77	+ .07
2447	1.85	1.63	+ .22
	Reverted P_2O_5.		
No. 2	2.58	2.39	+ .19
No. 3	1.92	2.11	− .19
2447	3.97	3.93	+ .04
	COTTON HULL ASHES.		
	Total P_2O_5.		
2408	8.75	8.59	+ .16
2409	8.75	8.77	− .02
2410	8.82	8.90	− .08
2453	10.23	10.26	− .03
2454	3.72	3.54	+ .18
	Soluble P_2O_5.		
2408	.67	.68	− .01
2409	.44	.48	− .04
	COTTON SEED MEAL.		
2421	2.71	2.68	+ .03
2449	2.56	2.56	.00
2450	2.70	2.74	− .04

CASTOR POMACE.

Station Number.	Phosphoric Acid. By Citrate method.	Phosphoric Acid. By Molybdate method.	The Citrate method gave more (+), or less (−), than the Molybdate method.
2439.....	2.35	2.38	− .03
TANKAGE.			
2442.....	2.29	2.29	.00
2618.....	8.84	8.94	− .10
BONE CHAR.			
2437.....	18.52	18.56	− .04
PHOSPHATIC GUANO OR ROCK.			
No. 1....	22.53	22.43	+ .10
Mona Island....	31.46—31.49	31.30	+ .18
Bolivian.....	17.35—17.38 17.42	17.09—17.13 17.14—17.24	+ .23
Gr. Cayman's Phosphate	25.84—25.85 26.01—26.11 26.12—25.82	26.12—26.18	− .19
So. Carolina Rock	25.61 25.72 25.49	25.53	+ .08

Of the sixty-seven determinations* by the citrate method but three differ from the molybdate method by more than 0.3 and but four others by more than 0.2 p. c. The greatest difference is 0.41, the average difference is 0.09 p. c. In 30 cases the citrate method gave 0.117 p. c. more, on the average, than the molybdate; in 33 cases, 0.079 p. c. less.

On the whole these results are strikingly similar to those obtained in 1880 by Wells. It will be observed in the ten cases where duplicates were made by each of the two methods that those by the citric process agree together rather more closely than those by the molybdic method. Only in case of Grand Cayman's has the difference between two citrate determinations on the same sample amounted to 0.3 p. c.

The process thus found so satisfactory with a large number of fertilizers gave trouble when applied in the same manner to Thomas-Slag and Keystone Concentrated Phosphate, as is seen from the following statement of the results of repeated trials:

* Or averages, in case duplicate determinations were made. It should be noted that these analyses were made rapidly as a part of the routine work of the Station, and without any special painstaking for the purpose of securing agreement.

The determinations in Thomas-Slag and Keystone Concentrated Phosphate were made each on 0.5 or 1 gm. of substance in 50 or 100cc. of either a nitro-hydrochloric or a sulphuric solution and by use both of the U. S. and of the German magnesia-mixture. The sulphuric solutions were obtained as directed by the German Experiment Stations' method, viz: by "heating 10 gm. of Slag in 50cc. of conc. sulphuric acid until white fumes appear for some time." (Versuchs Stationen, xxxv, 438). See page 262. The estimations marked O. are by Osborne.

1 gives the percentages obtained at first, by the process which had served for the estimations reported on pages 257–9. The low and irregular results appear to be due to insufficient stirring or standing of the liquids before filtration. They were, however, it is believed, obtained by treatment similar in these respects to that practised with the determinations tabulated on pages 257–9 and may emphasize the necessity of diligent and prolonged agitation when applying the citrate method to iron and aluminium phosphates. The highest result is 0·8 p. c. less than was obtained in **7** where the conditions differed simply by a double quantity of ammonium citrate and greater experience of the value of stirring.

2 is like the official method of the German Experiment Stations with the single difference that from the use of the U. S. magnesia-mixture the solution contained 1.75 gm. more of NH_4Cl. The solutions were quite cold before precipitation, and perhaps were insufficiently stirred.

3 was planned to follow exactly the German Experiment Stations' method. The free NH_3 is reckoned as 30 p. c. strength for convenience of comparison, but in following the method NH_3 of 10 p. c. was actually used according to the instructions (Versuchs Stationen, xxxv, 439). The 0.33 p. c. gain over **2** is possibly due to precipitation from warmer solutions and better stirring.

4 and **5** are by the German Experiment Stations' method with respective additions of 10cc. and 15cc. of NH_3 of 30 p. c., and in **5** of a double amount of magnesia-mixture with thorough agitation.

6 gives the same result as **4** and **5**, the quantity of substance taken as well as that of magnesia and free NH_3 being one-half as great.

A, B, and C, made by Messrs. Winton and Curtiss, with thorough stirring, confirm **4**, **5**, **6** and **7** and show that closely ac-

cordant results are obtained by different analysts, each working independently on different solutions and with two solvents.

The remaining determinations illustrate the effect of increasing relatively the amounts of magnesia-mixture or reducing that of citric acid, and especially show the influence of a great excess of ammonia, the results being carried up from 19.1 to 19.5 p. c.

7 is a duplicate of **5** except for being made on an aquaregia instead of oil of vitriol solution and more dilute.

8 as to conditions, differs from **6** by having half as much citrate and double the amount of magnesia and free ammonia; the phosphoric acid is raised 0.24 p. c.

9 and **10** finally, were obtained by the use of 5 gms. citric acid and a large quantity (75 cc.) of free NH_3. Two of the results in **9** are lower than the others probably because the beakers were too small to safely admit of sufficient stirring. The higher figures of **9** are in close agreement with those of **10.**

It now remains to consider the results of our work on the Keystone Concentrated Phosphate, a highly aluminous product containing but little calcium. See page 263.

11 and **12,** the first trials made, are probably low because not stirred sufficiently.

The remaining results certainly are not deficient on this account as no pains was spared to ensure superabundant agitation. They exhibit an extreme difference of 0.85 p. c. without giving any positive clue to the conditions which produce such variations. The highest figures generally accompany large excess of NH_3 or small volumes of solution, but duplicates made under the same conditions so far as can be specified, (F), and even by the same operator (**13, 17**) differ by 0. 25 to 0.40 p. c.

We had intended to give here the data for comparing the citrate method with the molybdic method in case of Thomas-Slag and Keystone Phosphate, but notwithstanding we have made many determinations and have many results by the molybdic method, we are as yet uncertain what is the true percentage of phosphoric acid in these substances and have to defer the consideration of that point to a future publication.

To further examine the sources of error involved in this method, several of the ignited and weighed precipitates from determinations by the citrate method, were subjected to partial analysis as follows: The precipitate was dissolved from the Gooch crucible by hot dilute hydrochloric acid and the residue, consist-

ESTIMATIONS OF PHOSPHORIC ACID IN THOMAS SLAG BY THE CITRATE METHOD.

	Substance taken.	Solvent.	Aliquot.	$\overline{Ci}$.	Mg. mixt. U. S.	Free NH_3 of 30 p. c.	Total volume.	P_2O_5 found.	Average P_2O_5 found.
1.....O.	1 gram	aqua regia	100 cc.	5 grams	50 cc.	30 cc.	200 cc.	18.28, 16.39 15.80, 17.16	16.91
2.....O.	1 "	oil-vitriol	50 "	10 "	25 "	15 "	190 "	18.40, 18.59	18.50
3.....O.	1 "	"	" "	" "	25* "	" "	190 "	18.72, 18.82 18.85, 18.91	18.83
4.....O.	1 "	"	" "	" "	" "	25 "	" "	18.91	18.91
5.....O.	1 "	"	" "	" "	50 "	30 "	160 "	18.94, 18.94	18.94
6.....O.	½ "	aqua regia	" "	" "	25 "	15 "	190 "	18.94	18.94
A ..... W. & C.	1 "	oil-vitriol	" "	" "	50 "	30 "	200 "	19.03, 18.85	18.94
B ..... W. & C.	1 "	aqua regia	" "	" "	25* "	15 "	190 "	18.91, 18.95	18.95
C ..... W.	1 "	"	" "	" "	25* "	" "	175 "	19.01	19.01
7.....O.	1 "	"	100 "	" "	50 "	30 "	210 "	19.14, 19.05	19.10
8.....O.	½ "	"	" "	5 "	" "	" "	190 "	19.17, 19.17 19.20, 19.17	19.18
9.....O.	1 "	"	" "	" "	" "	" "	260 "	19.49, 19.42 18.91, 19.10	19.23
D ..... W. & C.	1 "	oil-vitriol	50 "	" "	" "	" "	230 "	19.27, 19.23	19.25
10.....O.	1 "	"	" "	" "	" "	" "	215 "	19.47, 19.55	19.51

* German magnesia-mixture.

ESTIMATIONS OF PHOSPHORIC ACID IN KEYSTONE CONCENTRATED PHOSPHATE BY THE CITRATE METHOD.

	Substance taken.	Solvent.	Aliquot.	$\overline{\overline{Ci}}$.	Mg. mixt. U. S.	Free NH_3 of 30 p. c.	Total volume.	P_2O_5 found.	Average P_2O_5 found.
11.....O.	½ gram	aqua regia	50 cc.	10 grams	25 cc.	15 cc.	190 cc.	42.71, 42.53	42.62
12.....O.	1 "	"	100 "	" "	50 "	30 "	210 "	43.39, 42.69	43.04
E.....W. & C.	½ "	"	50 "	" "	" "	100 "	270 "	45.48, 45.47	45.48
13.....O.	½ "	"	" "	5 "	" "	75 "	195 "	45.80, 45.57 / 45.89,	45.75
14.....O.	1 "	"	100 "	" "	" "	100 "	270 "	45.79,	45.79
15.....O.	½ "	"	50 "	" "	" "	" "	220 "	46,02, 46.14	46.08
16.....O.	1 "	"	100 "	" "	" "	150 "	320 "	46.18,	46.18
17†.....O.	½ "	"	" "	" "	" "	75 "	245 "	46.14, 46.33 / 46.40,	46.29
F.....W. & C.	½ "	"	50 "	" "	" "	100 "	235 "	46.08, 46.32	46.20
G.....W. & C.	½ "	"	" "	" "	" "	150 "	285 "	46.12, 46.32	46.22

† To this was added 0.5 gm. pure fused $CaCl_2$.

ing of carbon and silica, was washed with water, dried at 100° C. and weighed. The loss of weight on subsequent ignition gave the quantity of carbon. The incombustible residue was reckoned as silica. The acid filtrate was boiled for some time to convert pyrophosphoric acid into orthophosphoric acid, and after cooling was carefully neutralized with ammonia. A few drops of acetic acid were added and after standing twelve hours in the cold any ferric or aluminic phosphate which had separated was filtered out, ignited and weighed. In this filtrate lime was precipitated in the cold by ammonium oxalate; after filtration the calcium oxalate was dissolved in hydrochloric acid and reprecipitated hot with excess of ammonium oxalate from a slightly acid solution and weighed as CaO. The two filtrates were united and made strongly ammoniacal to precipitate ammonium magnesium phosphate. A preliminary experiment showed that the filtrate after this precipitation contained both magnesia and phosphoric acid, the latter not having been rendered tribasic by the treatment with hydrochloric acid. The filtrate from the ammonium-magnesium phosphate was therefore precipitated by addition of magnesia mixture, and the second smaller amount of magnesium pyrophosphate stated in the analyses is the quantity thus obtained. Any excess of magnesia in the original precipitate therefore could not be determined by this plan of procedure, and with some unconverted pyro-phosphoric acid must have contributed to the "loss."

ANALYSES OF IGNITED CITRATE PRECIPITATES.

	Pure Bone. 2362.		Superphosphate. 2394.	
	gm.	p. c.	gm.	p. c.
Carbon	.0015	.41	.0006	.19
Silica	.0000	—	.0004	.12
Calcium oxide	.0094	2.59	.0068	2.13
Magnesium pyrophosphate	.3387	93.61	.3002	94.28
" "	.0068	1.88	.0057	1.79
Loss	.0054	1.51	.0047	1.49
	.3618	100.00	.3184	100.00

	Grand Cayman's Phosphate.		South Carolina Rock.	
	gm.	p. c.	gm.	p. c.
Carbon	.0018	.44	.0006	.15
Silica	.0016	.40	.0004	.10
Calcium oxide	.0083	2.05	.0129	3.21
Ferric and aluminic phosphate	.0029	.71	.0014	.35
Magnesium pyrophosphate	.3809	94.40	.3762	93.58
" "	.0051	1.26	.0088	2.19
Loss	.0029	.74	.0017	.42
	.4035	100.00	.4020	100.00

	Bolivian Guano.		Dissolved Bone Black. 2182.	
	gm.	p. c.	gm.	p. c.
Carbon	.0013	.48	.0007	.27
Silica	.0006	.24	.0005	.19
Calcium oxide	.0108	3.95	.0053	2.05
Ferric and aluminic phosphates	——	——	.0008	.31
Magnesium pyrophosphate	.2473	91.22	.2460	95.21
" "	.0102	3.76	.0068	2.62
Loss	.0009	.35		
	.2711	100.00	.2601	100.65

The total magnesium pyrophosphate recovered from these precipitates was 95.49, 96.07, 95.66, 95.77, 94.98, 97.83 p. c., respectively. The highest percentage it will be noticed is from an analysis which somewhat overruns 100 p. c. The precipitates yielded an average of 96 p. c. of magnesium pyrophosphate, 2.7 p. c. of lime, and 1.3 p. c. of magnesia (?) carbon, silica, and iron and aluminium phosphates.

Considering that the foregoing analyses were made with but 0.25 to 0.4 gm. of substance which had been ignited upon and dissolved out of asbestos, their agreement is such as to show that the precipitate is nearly constant in composition whether salts of calcium or those of iron and aluminium preponderate in the solution from which it is thrown down. From the Grand Cayman's, rich in iron and aluminium, but little more of these metals enters the precipitate than from Carolina Rock or Bone Black.

Herzfeld and Feuerlein and also Reitmair consider that the incomplete precipitation of phosphoric acid is ordinarily due to a soluble ammonium-magnesium phospho-citrate which is not completely decomposed by excess of magnesia, and the compensation comes from precipitation of ammonium-calcium phosphate of composition similar to that of the ammonium-magnesium phosphate.

Grupe and Tollens have, however, shown that the ignited precipitate probably contains orthophosphoric acid and conclude that the calcium is present in part at least as tricalcic phosphate. Petermann states that "basic magnesium citrate" is liable to deposit with the precipitate when it stands too long (48 hours) before filtering, and Grupe and Tollens are probably correct in their belief that in all cases trimagnesic citrate, and where lime is present tricalcic citrate, is thrown down since the ignited precipitate gives evidence of the presence of magnesium oxide and calcium oxide or

carbonate, while citric acid is indicated by the carbonization of the precipitate on ignition.

In the Station Report for 1880, p. 103, is written as follows with regard to the citrate method as then elaborated by Mr. Wells: "The method is in our opinion quite accurate enough for the analysis of fertilizers, and is now regularly employed for that purpose in the Station, since its use saves much time and labor." When that paragraph was written it had been determined to use thenceforward during the year 1881, in all fertilizer analyses, the citrate method for one and the molybdic method for another of the duplicate determinations which are invariably made, and in that year a considerable number of fertilizers were so analyzed with good results. It was, however, found in case of a few fertilizers presumed or known to contain iron or alumina in considerable quantities, that the two methods could not be brought to give agreeing percentages and the use of the citrate method was accordingly discontinued as it was then impossible to devote further time to its investigation.

Referring to the analyses given on pages 257–9 we find among the "superphosphates," the two samples which differed most largely in the per cent. of phosphoric acid obtained by the molybdic and citric methods.

No. 2415 yielded 0.35 p. c. less and No. 2456 0.41 p. c. more of phosphoric acid by the citric method than by the molybdic. The samples contained respectively 12.20 and 12.27 p. c. of phosphoric acid, so that in these extreme cases the full range of error was 0.75 p. c. of the samples and 6.13 p. c. of the phosphoric acid.

It is evident that a mode of procedure which admits, though but rarely, of such discrepancies cannot be safely employed by an Experiment Station, when as is the case in this country, the chemists employed by brokers and manufacturers and by other Experiment Stations are accustomed to rely upon the molybdic method as the standard.

In France the citrate process appears to have been considerably employed and for ten years or more, we believe, it has been an official method of the Belgian Experiment Stations. The citrate method found little favor in Germany until in 1888 it was adopted for the analysis of Thomas-Slag by the Associated Agricultural Experiment Stations of the German Empire at their congress at Wiesbaden in September, 1888. The process thus sanctioned

differs slightly from that of Vogel which has been referred to on page 255.

It is our impression that in Belgium and Germany, in some instances, experiment stations and manufacturers have mutually agreed to use and abide by the citrate method applied according to carefully defined instructions, and they undoubtedly find very great advantage in so doing, for the errors of the method are commonly quite small and in the long run balance each other, being about as often on the plus as on the minus side, while as respects ease and rapidity of working and economy of reagents the citrate method is greatly superior, so that its results cost but perhaps one-third as much as those by the molybdic method.

The subjoined comparison of the modifications of the citrate method used or alluded to in this paper is given for convenience of reference.

	For Phosphates with little Fe and Al.		For Thomas-Slag.	
	Wells.	Osborne.	Vogel.	Ger. Exp. St.
Substance	1 gm.	0.5–1 gm.	0.5	1 gm.
Volume of aliquot	100 c. c.	100 c. c.	50 c. c.	50 c. c.
Citric acid	10–15 gm.	5 gm.	5 gm.	10 gm.
Magnesia mixture	30–40 c. c.	50 c. c.	20 c. c.	25 c. c.
Additional NH_4Cl		3.5 gm.		
Volume of 10 % Ammonia	90–100 c. c.	90 c. c.*	110 c. c.†	90 c. c.
Total volume of liquid	350–400 c. c.	190 c. c.	110 c. c.	190 c. c.

* 30 c. c. ammonia of 30 %.

† 10–12 c. c. strong ammonia.

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STATE OF CONNECTICUT.

ANNUAL REPORT

OF

The Connecticut Agricultural

EXPERIMENT STATION

For 1890.

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1892, Sp. 3.
Conn. Station

OFFICERS AND STAFF FOR 1890.

STATE BOARD OF CONTROL.

Ex-officio.

His Exc. MORGAN G. BULKELEY, *President.*

Appointed by Connecticut State Agricultural Society:	Term expires
Hon. E. H. HYDE, Stafford, *Vice-President.*	July 1, 1891.
Appointed by Board of Trustees of Wesleyan University:	
Prof. W. N. RICE, Middletown.	1891.
Appointed by Governor and Senate:	
EDWIN HOYT, New Canaan.	1892.
H. L. DUDLEY, New London.	1893.

Executive Committee.

Appointed by Board of Agriculture:

T. S. GOLD, West Cornwall. 1892.

Appointed by Governing Board of Sheffield Scientific School:

W. H. BREWER, New Haven, *Secretary and Treas.* 1893.

Ex-officio.

S. W. JOHNSON, New Haven, *Director.*

Chemists.

E. H. JENKINS, Ph.D., *Vice-Director.*
A. L. WINTON, Jr., Ph.B.
T. B. OSBORNE, Ph.D.
R. S. CURTISS, Ph.B.*
A. W. OGDEN, Ph.B.†

Mycologist.

ROLAND THAXTER, Ph.D.

Stenographer and Clerk.

Miss F. M. BIGELOW.

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helper.

HUGO LANGE.

* Till Oct. 1st. † From Oct. 1st.

ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established in accordance with an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, useful or injurious insects, moulds, blights, mildews, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station makes analyses of Fertilizers, Seed-Tests, etc., etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.

2. That the samples are taken from stock now in the market, and in accordance with the Station instructions for sampling.

3. That the samples are fully described and retail prices given on the Station "Forms for Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs and like Associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.

All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the use of individuals will be charged for at moderate rates. The Station will undertake no work, the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of general interest will be published in Bulletins, of which copies are sent to each Post Office in this State, and to every citizen of the State who applies for them. These results will be summed up in the Annual Reports made to the Governor.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agricul-

ture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties, sent on application.

☞ Parcels by Express, to receive attention should be *prepaid*, and all communications should be directed, *not to any individual officer*, but simply to the

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

☞ Station Grounds, Laboratories and Office are on Suburban st., between Whitney avenue and Prospect st., 1¼ miles North of City Hall. Suburban st. may be reached by the Whitney ave. Horse Cars, which leave the corner of Chapel and Church sts. three times hourly, viz: on the striking of the clock and at intervals of twenty minutes thereafter.

☞ The Station has Telephone connection and may be spoken from the Central Telephone Office, 118 Court st., or from Peck & Bishop's Office in Union R. R. Depot.

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REPORT OF THE BOARD OF CONTROL.

To His Excellency, Morgan G. Bulkeley, Governor of Connecticut:—

The Board of Control of the CONNECTICUT AGRICULTURAL EXPERIMENT STATION respectfully submits its Annual Report for the year ending November first, 1890:

As required by the act concerning Commercial Fertilizers the Station has made and published one or more analyses of all brands offered for sale in the State so far as it has been able to obtain them. The Station employed special deputies during April and May last who visited 84 towns and a considerably larger number of villages in all parts of the State and drew from stock in the hands of dealers 468 samples of fertilizers. One hundred and forty-six distinct brands of fertilizers are known to be on sale but the analyses of manures and manurial waste products, etc., has increased the total number of fertilizer-analyses to 310.

The examinations of suspected butter, molasses and vinegar desired by the Dairy Commissioner, while not obligatory on the Station have yet been made gratuitously whenever called for and expert testimony has been furnished in court whenever required. Thirty-one samples of molasses, 12 of maple syrup, 33 of vinegar and 15 of butter or oleomargarin have thus been examined within the year.

Thirteen other samples of butter and 106 samples of milk have also been examined, chiefly for dairy farmers or for creameries, to test the milk of herds or to discover suspected watering or skimming.

Some 45 or 50 samples of feeding stuffs have been analyzed or are now being analyzed, a part of them at the request of stock-feeders who are using bought feed, and a part in connection with the field experiments of the Station.

As usual a very considerable amount of time has been spent in the testing of analytical methods, particularly those for the determination of phosphoric acid in fertilizers and for the rapid estimation of fat in milk.

The nature and composition of the albuminoids or proteids of oats have been the subject of extended study by Dr. Osborne, who has also worked upon the proteids of maize, under the advice of Professor R. H. Chittenden, in the Sheffield biological laboratory of Yale University.

The following field experiments have been carried out this year under the superintendence of Dr. Jenkins, Vice-Director.

1. An experiment coöperative with a number of other Stations "to study the composition of corn grown in different localities and to determine the influence of climatic conditions on varieties of corn native to one latitude when moved to a higher or lower latitude."

2. An experiment on the relative yield and chemical composition of corn planted in hills and in drills.

3. An experiment on the continuous growth of corn year after year on the same land, fertilized *a.*) with farm manure, *b.*) with commercial fertilizers.

4. A continuous experiment to test the relative yearly yield of potatoes from seed of different size, when the selection of seed is practiced for a course of years.

5. A special nitrogen experiment with potatoes.

6. An experiment on the relative value of certain raw phosphates and superphosphate.

In connection with investigations regarding grasses, 18 samples of orchard grass seed collected in the markets of the State, as well as in New York and Boston, have been tested with regard to their purity and vitality.

Mr. J. B. Olcott has had charge of the Forage Garden on the Station Grounds and also, in coöperation with the Station, has established on his farm in South Manchester a more extensive plantation of valuable or promising grasses for the purpose of obtaining pure seed and especially of observing for a series of years the characters of varieties of common species which he has gathered and intends gathering from various localities in this and other States, territories and countries.

During the past year Dr. Thaxter, Mycologist to the Station, has continued the study of fungus diseases of plants, with field experiments for the prevention of certain of them affecting the onion, quince, grape, etc. The special subject of the season has been the disease known as potato scab. By means of artificial cultivation and inoculations, the cause of this disease as it occurs in Connecticut has been shown to be a peculiar fungus. The subject is still undergoing investigation.

Four bulletins containing 45 octavo pages have been issued during the year and mailed to each newspaper, postmaster, and secretary of a farmer's organization and to more than 6500 citizens of the State.

Ten weekly statements have likewise been issued to bring the results of laboratory work more promptly before farmers. These are sent to leading agricultural papers and to each secretary of a farmers' organization.

For a detailed account of the work of the Station reference must be had to the Report of the Director now in preparation.

The accompanying Report of the Treasurer exhibits the financial affairs of the Station for the fiscal year which ended June 30, 1890.

All of which is respectfully submitted.

WILLIAM H. BREWER, *Secretary.*

New Haven, Conn., October 31, 1890.

REPORT OF THE TREASURER.

WM. H. BREWER, *in account with the Connecticut Agricultural Experiment Station for the fiscal year ending June 30th, 1890.*

RECEIPTS.

From the State Comptroller	$8,000.00	
From the U. S. Treasurer	7,500.00	
Analysis Fees due from previous fiscal year, collected this year	260.00	
Analysis Fees of the fiscal year	3,961.50	
Miscellaneous Receipts	47.03	
		$19,768.53

EXPENDITURES.

	State Account.	United States Account.	Total.
Salaries	$5,130.00	$6,465.00	$11,595.00
General Laboratory expenses	1,126.83		1,126.83
Mycological expenses		122.77	122.77
Grass and Forage Investigation	580.06		580.06
Field Experiments		441.56	441.56
Gas	254.55		254.55
Water	147.00		147.00
Coal	547.00		547.00
The Establishment, Repairs, Grounds, etc.	565.74		565.74
Improvements, other than ordinary Repairs	2,093.88		2,093.88
Finishing Mycological Laboratory		284.13	284.13
Telephone	96.83		96.83
Printing	636.74	186.54	823.28
Postage	92.46		92.46
Stationery	179.47		179.47
Library	260.65		260.65
Traveling expenses of the Board of Control	20.36		20.36
Collecting Fertilizers	319.74		319.74
Unclassified Sundries	217.22		217.22
	$12,268.53	$7,500.00	$19,768.53

MEMORANDUM.

The year's accounts were audited September 19, 1890, by the Auditors of the State Public Accounts.

The Analysis Fees of certain fertilizers believed to have been on sale in the State since May 1st and subject to the law concerning the sale of fertilizers, if hereafter collected will go to the new account.

WILLIAM H. BREWER, *Treasurer.*

REPORT OF THE DIRECTOR.

On the following pages is a full report of the work done by this Station during the year in the analysis of fertilizers, with a review of the market quotations of fertilizer chemicals and manurial waste products for the year.

The investigations in the botanical laboratory and the field observations and experiments of the mycologist are reported by Dr. Thaxter.

A paper by Dr. Osborne gives in full the method and results of his work on the proteids of the oat kernel.

Most of the analyses of feeding stuffs made during the year are discussed and also the results of a field experiment on the effects of growing maize in hills and drills.

These papers cover more than 200 pages, the limit prescribed by State law, and the expense for the additional printing is borne by the Station. There still remains a considerable amount of material which cannot be printed for lack of space. This includes the report of the examinations of seeds, analyses of potatoes, work done for the Dairy Commissioner and a coöperative experiment on the composition of corn grown in different localities.

The discussion of the experiments with potatoes it is deemed best to defer till further results have been obtained.

THE CONNECTICUT FERTILIZER LAW.

The General Assembly at its session in 1882 passed a Fertilizer Law which went into effect September 1, 1882, and which repealed and took the place of all previous legislation on this subject. The law is still in force without any amendment.

Copies of the law may be had on application to the Station. Attention is specially called to the following requirements.

1. In case of fertilizers that retail at ten dollars or more per ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER shall have provided labels or statements and shall have paid the fee. Sections 1 and 3.

The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, viz: Nitrogen, Phosphoric acid and Potash. The analysis-fees in case of any fertilizer will therefore be ten, twenty or thirty dollars, according as one, two or three of these ingredients are contained or claimed to exist in the fertilizer.

2. The law also requires, in case of any fertilizer selling at ten dollars or more per ton, that a *sealed sample* shall be deposited with the Director of the Station by the MANUFACTURER OR IMPORTER, and that a *certified statement* of composition, etc., shall be filed with him.

A statement of the per cents. of Nitrogen, Phosphoric acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the per cent. of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The per cent. of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of soluble and reverted.

The percentage of insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the chemical composition may take account of the two ingredients: Nitrogen, Phosphoric Acid.

For Potash Salts give always the per cent. of Potash (potassium oxide); that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price* shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4.

4. All "CHEMICALS" that are applied to land, such as: Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Lime (Gypsum or Land Plaster), Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 9 of the Act.

It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in section 9, that all fertilizers be analyzed and it requires the parties making or selling them to pay for these analyses in part; the State itself paying in part by maintaining the Experiment Station.

OBSERVANCE OF THE FERTILIZER LAW.

MANUFACTURERS who have paid the Analysis Fees as required by the Law, and Fertilizers for which fees have been thus paid for the year ending May, 1891.

Firm.	*Brand of Fertilizer.*
Apothecaries Hall Co., Waterbury, Conn.	Victor Phosphate.
Baker, H. J. & Bro., 215 Pearl St., N. Y.	Pure Ground Bone. A. A. Ammoniated Superphosphate. Potato Fertilizer. Corn Fertilizer. Castor Pomace.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Kainit. Pure Dry Fish. Stockbridge Tobacco Manure. " Corn and Grain Manure. " Forage Crop Manure. " Vegetable manure. " Fruit Manure. Bowker's Hill and Drill Phosphate. " Fish and Potash. " Ammoniated Dissolved Bone. " Fresh Ground Bone.
Bradley Fertilizer Co., 27 Kilby Street, Boston, Mass.	Bradley's Superphosphate. " Potato Manure. " Complete Manure for Potatoes and Vegetables. " for Top Dressing Grass and Grain. " for Corn and Grass. " Pure Fine Ground Bone. " Circle Brand Ground Bone with Potash. " Fish and Potash, Anchor Brand. " Fish and Potash, Triangle A Brand. B. D. Sea Fowl Guano. Original Coe's Superphosphate. Farmer's New Method Fertilizer.
Church, Joseph & Co., Tiverton, R. I.	Fish and Potash. Dry Ground Fish.
Coe, E. Frank, 16 Burling Slip, N. Y.	High Grade Ammoniated Bone Superphosphate. Red Brand Excelsior Guano. Gold Brand Excelsior Guano. Potato Fertilizer. Alkaline Bone. Ground Bone. Fish and Potash.

Firm.	*Brand of Fertilizer.*
Coe, Russell, Meriden, Conn.	Superphosphate.
Collier White Lead and Oil Co., St. Louis, by F. Ellsworth, Hartford.	Collier Castor Pomace.
Cooper's, Peter, Glue Factory, 17 Burling Slip, N. Y.	Pure Bone Dust.
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	New Rival Ammoniated Superphosphate. Buffalo Superphosphate No. 2. Special Potato Manure. Pure Ground Bone. Ammoniated Bone Superphosphate. Potato, Hop and Tobacco Phosphate. Queen City Phosphate. Vegetable Bone Superphosphate. Ammoniated Wheat and Corn Phosphate.
Cumberland Bone Co., Portland, Maine.	Cumberland Superphosphate. Seeding Down Fertilizer.
Darling, L. B. Fertilizer Co., Pawtucket, R. I.	Animal Fertilizer. Extra Bone Phosphate. Pure Ground Bone.
Davidge Fertilizer Co., 121 Front St., N. Y.	Davidge's Special Favorite. " Potato Manure. " Vegetator.
Downs & Griffin, Birmingham, Conn.	Ground Bone.
Fall, E. B., Middletown, Conn.	Ground Bone.
Farmers' Fertilizer Co., 230 W. Water St., Syracuse, N. Y.	Standard Special Formula. Fish and Potash.
Great Eastern Fertilizer Co., Rutland, Vt.	Great Eastern General Phosphate for Oats, Buckwheat and Seeding Down. Great Eastern General Fertilizer for Grass and Grain. Great Eastern Vegetable, Vine and Tobacco Fertilizer.
Kelsey, E. R., Branford, Conn.	Fish and Potash.
Lister's Agricultural Chemical Works, Newark, N. J.	Standard Superphosphate of Lime. Ammoniated Dissolved Bone. Celebrated Ground Bone.
Ludlam Frederick, 140 Maiden Lane, N. Y.	Ludlam's Cereal Fertilizer. " Cecrops Fertilizer.
Mapes Formula & Peruvian Guano Co., 158 Front St., N. Y.	Potato Manure. Complete Manure for Light Soils. " " for General Use. " " "A" Brand. Tobacco Manure, Connecticut Brand. " " Wrapper Brand. Fruit and Vine Manure.

Firm.	*Brand of Fertilizer.*
Mapes Formula & Peruvian Guano Co., 158 Front St., N. Y.	Peruvian Guano. Corn Manure. Fine Dissolved Bone. Seeding Down Manure. Grass and Grain Spring Top Dressing.
Miller, G. W., Middlefield, Conn.	Flour of Bone Phosphate. Pure Ground Bone.
Miller, H. S. & Co., Newark, N. J.	Harvest Queen Phosphate. Bone Meal. Special Potato Manure. Standard Superphosphate. Corn Fertilizer. Ammoniated Dissolved Bone.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's Complete Fertilizer. " Ammoniated Bone Phosphate. " Fish and Potash. " Ground Bone.
Olds & Whipple, Hartford, Conn.	Olds & Whipple's Special Phosphate.
Peck Brothers, Northfield, Conn.	Pure Ground Bone.
Plumb & Winton, Bridgeport, Conn.	Bone Fertilizer.
Quinnipiac Co., 83 Fulton St., N. Y.	Quinnipiac Phosphate. " Pine Island Phosphate. " Potato Manure. Market Garden Manure. Fish and Potash, Crossed Fishes Brand. Fish and Potash, Plain Brand. Dry Ground Fish. Bone Meal.
Read Fertilizer Co., Box 3121, New York City.	Farmers' Friend Fertilizer. Lion Brand Fertilizer. High Grade Farmers' Friend. Bone, Fish and Potash.
Red Seal Castor Oil Co., St. Louis, Mo., by Olds & Whipple, Hartford.	Red Seal Castor Pomace.
Reese, J. S. & Co., New Bedford, Mass.	Bay State Fertilizer. Great Planet "A" Fertilizer. Reese's Concentrated Potato and Corn Manure. Reese's Concentrated Tobacco and Cabbage Manure. Reese's New England Favorite. Pilgrim Fertilizer. King Philip Alkaline Bone Superphosphate.
Rogers & Hubbard Co., Middletown, Conn.	Pure Raw Knuckle Bone Flour. Pure Ground AX Bone. Soluble Potato Manure. Fairchild's Corn Formula. " Seeding Down Formula.

Firm.	*Brand of Fertilizer.*
Sanderson, L., Long Wharf, New Haven, Conn.	Formula A. Sulphate of Ammonia. Dried Blood. Nitrate of Soda. Blood, Bone and Meat. Dissolved Bone Black. Muriate of Potash. Sulphate of Potash. Fine Ground Bone.
Shoemaker & Co., M. L., Philadelphia, by F. Ellsworth, Hartford.	Swift-Sure Superphosphate. Swift-Sure Bone Meal.
Stearns Fertilizer Co., 133 Water St., N. Y.	Ammoniated Bone Superphosphate. Potato Grower.
Stewart, W. D. & Co., 8 Congress St., Boston, Mass.	Soluble Pacific Guano. Pacific Fish and Potash.
Wilcox, Leander, Mystic Bridge, Conn.	Wilcox's Acidulated Fish Guano. " Dry Ground Fish Guano.
Wilkinson & Co., 54 Williams St., N. Y.	Economical Bone Fertilizer.
Williams & Clark Fertilizer Co., 81 Fulton St., N. Y.	Americus High Grade Special for Tobacco, &c. Potato Phosphate. Americus Ammoniated Bone Phosphate. Americus Pure Bone Meal. Royal Bone Phosphate.

ANALYSES OF FERTILIZERS.*

During 1890, 314 samples of fertilizers have been analyzed. Of these, a small number were examined for private parties and for testing methods in connection with other Experiment Stations, and the remainder for the general use of the citizens of the State.

During April and May last Messrs. F. R. Curtiss of Stratford and Dennis Fenn of Milford, agents of this Station, collected samples of Commercial Fertilizers in all parts of Connecticut.

Eighty-four towns and a considerable number of villages have been visited, distributed as follows:

Hartford Co.	17
Tolland Co.	7
Windham Co.	15
New London Co.	5
Middlesex Co.	11
New Haven Co.	10
Fairfield Co.	12
Litchfield Co.	7
	84

These gentlemen drew about 468 samples, using the method of sampling which is described on page 91 of the Report of this Station for 1884.

In this way one or more samples were secured of nearly every brand of fertilizer which is offered for sale within the State. When several samples of a single brand were drawn in different parts of the State the analysis was performed, not on any single sample, but on a mixture made of an equal weight of each of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of any single sample.

The Station agents are instructed in every case to open at least three packages of each brand for sampling, and if the number of packages is large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core through the entire length of the bag or barrel.

* The matter of this and several subsequent pages, explanatory of the sampling and valuation of fertilizers, is copied, with a few alterations, from the Report for 1887. This repetition appears to be necessary for the use of readers who have not seen former Reports.

As a rule, the Station will not analyze samples—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

The Station desires the coöperation of farmers, farmers' clubs, and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. All samples drawn by other than Station agents *must* be drawn in accordance with the Station's Instructions for sampling, and properly certified, if the Station analysis is desired. A copy of these instructions and blank certificates will be sent on application.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a copy of it is sent to the party who furnished the sample, and also to the manufacturer, in order that there may be opportunity for explanation or protest, if desirable, before the results are published in the Bulletin.

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

Explanations Concerning the Analysis of Fertilizers and the Valuation of their Active Ingredients.

Revised.

Nitrogen is the most rare, and commercially the most valuable fertilizing element.

Free Nitrogen is indeed universally abundant in the common air, but in this form its effects in nourishing vegetation are as yet obscure.

Organic Nitrogen is the nitrogen of animal and vegetable matters, which is chemically united to carbon, hydrogen and oxygen. Some forms of organic nitrogen, as those of blood, flesh and seeds, are highly active as fertilizers; others, as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated.

Ammonia (NH_3) *and nitric acid* (N_2O_5) are results of the decay of *organic nitrogen* in the soil and manure heap, and contain Nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda. 17 parts of ammonia or 66 parts of pure sulphate of ammonia contain 14 parts of nitrogen. 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

Phosphorus is, next to nitrogen, the most costly ingredient of Fertilizers, in which it always exists in the form of phosphates, usually those of calcium, iron and aluminum, or in case of some "super-phosphates," in the form of free phosphoric acid.

Soluble Phosphoric acid implies phosphoric acid or phosphates that are freely soluble in water. It is the characteristic ingredient of Superphosphates, in which it is produced, by acting on "insoluble" or "reverted" phosphates, with diluted sulphuric acid (oil of vitriol). Once well incorporated with the soil, it gradually becomes reverted phosphoric acid.

Reverted (reduced or precipitated) Phosphoric acid means strictly, phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid. In present usage the term signifies the phosphoric acid (of various phosphates) that is freely taken up by a strong solution of ammonium citrate, which is therefore used in analysis to determine its quantity. "Reverted phosphoric acid" implies phosphates that are readily assimilated by crops.

Recent investigation tends to show that soluble and reverted phosphoric acid are on the whole about equally valuable as plant food, and of nearly equal commercial value. In some cases, indeed, the soluble gives better results on crops, in others the reverted is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric acid implies various phosphates not soluble in water or ammonium citrate. In some cases the phosphoric acid is too insoluble to be readily available as plant-food. This is especially true

of the crystallized green Canada Apatite. Bone-black, bone-ash, South Carolina Rock and Navassa Phosphate when in coarse powder are commonly of little repute as fertilizers though good results are occasionally reported from their use. When *very finely pulverized* ("floats") they more often act well, especially in connection with abundance of decaying vegetable matters. The phosphate of calcium in raw bones is nearly insoluble, because of the animal matter of the bones, which envelops it; but when the latter decays in the soil, the phosphate remains in essentially the "reverted" form. The phosphoric acid of "Thomas-Slag" and of "Grand Cayman's Phosphate" is freely taken up by crops.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid" (P_2O_5) also termed among chemists, phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

POTASSIUM is the constituent of Fertilizers, which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride).

The Valuation of a Fertilizer, as practised at this station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and similar articles, for which $30 to $50 per ton are paid, depend chiefly for their trade-value on the three substances, *nitrogen*, *phosphoric acid* and *potash*, which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above named Ingredients*, a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

The average Trade-values or retail cost in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash, as found in the New England, New York and New Jersey markets, are as follows :—

The Trade-Values for 1890 of Fertilizing Ingredients in Raw Materials and Chemicals.

The average Trade-Values or *retail cost per pound* of the ordinarily occurring forms of nitrogen, phosphoric acid and potash are as follows:

	Cts. per lb.
Nitrogen in ammonia salts	17
nitrates	14½
Organic nitrogen in dry and fine ground fish, meat and blood	17
in cotton seed meal and castor pomace	15
in fine bone and tankage	16½
in fine medium bone and tankage	13
in medium bone and tankage	10½
in coarser bone and tankage	8½
in hair, horn shavings and coarse fish scrap	8
Phosphoric acid, soluble in water	8
in ammonium citrate*	7½
in dry ground fish, fine bone and tankage	7
in fine medium bone and tankage	6
in medium bone and tankage	5
in coarser bone and tankage	4
in fine ground rock phosphate	2
Potash as high-grade Sulphate and in forms free from Muriate (or Chlorides)	6
as kainit	4½
as muriate	4½

These Trade-values were agreed upon by the Experiment stations of Massachusetts, New Jersey, and Connecticut, for use in their respective States during 1890. They are the average prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those raw materials which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices* at the large markets of standard raw materials, such as:

Sulphate of Ammonia,	Muriate of Potash,
Nitrate of Soda,	Sulphate of Potash,
Dried blood,	Plain Superhosphate,
Azotin,	Dry Ground Fish,
Ammonite,	Bone and Tankage,

Ground So. Carolina Rock.

* Dissolved from 2 grams of the unground phosphate previously extracted with pure water, by 100 c. c. neutral solution of Ammonium Citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

Valuation of Superhosphates, Special Manures and Mixed Fertilizers of High Grade.

The organic nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality.

Insoluble Phosphoric Acid is reckoned at 3 cents, unless found to be from rock phosphate. In this latter form Insoluble Phosphoric Acid costs but 2 cents per pound. Potash is rated at 4½ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of Potash is reckoned at 6 cents per pound.

In most cases the valuation of the Ingredients in Superhosphates and Specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. These charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investments, bad debts, and finally, profits.

The majority of the manufacturers agree that the average cost of mixing, bagging, handling and cartage ranges from $3.00 to $4.50 per ton.

In 1890 the average selling price of Ammoniated Superphosphates, and Guanos was $33.80, the average valuation was $28.57, and the difference $5.23—an advance of 18.3 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

In case of Special Manures the average cost was $39.18, the average valuation $32.90, and the difference $6.28, or 19.0 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of Nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

In case of *Ground Bone*, the sample is sifted into four grades and we separately compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton, by the per cent. of each grade, taking $\frac{1}{100}$th of that product, multiplying it by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade, thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

The uses of the "Valuation" are two-fold:

1. To show whether a given lot or brand of fertilizers is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price; but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

2. Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for analysis cannot decide accurately what is the *form* of nitrogen, etc., while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second-named use of valuation frequent changes of the trade-value are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth, when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at at the beginning of a year should be adhered to as nearly as possibly throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

The *Agricultural value* of a fertilizer is measured by the benefit received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that Peruvian guano, superphosphates, fish-scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

CLASSIFICATION OF FERTILIZERS ANALYZED.

The fertilizers and manurial waste products analyzed at the Station laboratory from November 1st, 1889, to November 1st 1890, were as follows :

RAW MATERIALS COMMONLY USED IN MIXED FERTILIZERS.

1. *Containing Nitrogen as the Chief Valuable Ingredient.*

Nitrate of Soda	
Sulphate of Ammonia	
Dried Blood	
Cotton Seed Meal	
Castor Pomace	
Hoof Meal	

2. *Containing Phosphoric Acid as the Chief Valuable Ingredient.*

Thomas-Slag	
Precipitated Phosphate	
Dissolved Bone Black	
Rock Phosphate	1

3. *Containing Potash as the Chief Valuable Ingredient.*

Double Sulphate of Potash and Magnesia	
Muriate of Potash	
Kainit	

4. *Containing Nitrogen and Phosphoric Acid.*

Bone Manures	2
Bone and Potash	
Tankage	

MIXED FERTILIZERS.

Nitrogenous Superphosphates and Guanos	10
Special Manures	4
Home-mixed Fertilizers	

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes	2
Unleached Wood Ashes	1
Lime-kiln Ashes	
Limestone	
Wool Waste	
Tank Water and Settlings	
Plaster	
Yard Manure	
Rockweed and Sponge	
Total	31

These analyses are discussed in the order above given on the following pages.—In all cases where the contrary is not stated, the samples were drawn by agents of the Station. The regular retail prices are in all cases given. By special terms with the dealer in many cases the actual cash prices paid have been less than those here stated.

I. Raw Materials of High-Grade Containing Nitrogen as the Chief Valuable Ingredient.

Nitrate of Soda.

Nitrate of Soda is mined in Chili and purified there before shipment. It usually contains about 16 per cent. of nitrogen, equivalent to 97 per cent. of pure nitrate of soda. It contains besides, a little salt and some moisture. The usual guarantee is "96 per cent." of nitrate of soda equivalent to 15.8 per cent. of nitrogen.

2690. Sold by L. Sanderson, New Haven.

Analysis.

Water	1.86
Salt	.54
Sulphate of Soda	.22
Matters insoluble in water	.08
* Pure nitrate of soda	97.30
	100.00
* Containing nitrogen	16.06
Cost per ton	$50.00
Nitrogen costs per pound in cents	15.6

Sulphate of Ammonia.

This article, now made on a large scale as a by-product of gas-works, usually contains over 20 per cent. of nitrogen, the equivalent of from 94 to 97 per cent. of sulphate of ammonia. The rest is chiefly moisture. The usual guarantee is 25 per cent. of ammonia, which is equivalent to 20.6 per cent. of nitrogen, but commercial sulphate of ammonia commonly contains less than that quantity.

2691. Sold by L. Sanderson, New Haven.

ANALYSIS.

Nitrogen	20.86
Equivalent ammonia	25.3
Cost per ton	$75.00
Nitrogen costs per pound in cents	18.

DRIED BLOOD.

2721. A single sample of this material drawn from stock of L. Sanderson by a Station agent contained 12.90 per cent. of nitrogen. The price charged was $40.00 per ton.

Nitrogen costs per pound 15.5 cents.

COTTON SEED MEAL.

The seed of the cotton plant, after ginning to remove the fiber, passes through a mill which hulls or decorticates it. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer.

Sometimes, however, hulls and seed are ground together, making "undecorticated meal" which contains considerably less nitrogen and has correspondingly less money value as a fertilizer or as a feed. When the meal has undergone heating or fermentation, its color changes from a deep yellow to brown or reddish brown. It is then unfit for cattle food and is sold at a cheaper rate as a fertilizer.

2658. "Off Color," unfit for cattle food. Stock of Olds & Whipple. Not sampled by Station agent.

2723. From stock of L. Sanderson, New Haven.

2758. "Off Color," from stock of C. L. Spencer, Suffield. Not sampled by Station agent.

2864. From stock bought by F. Culver, West Suffield. Sampled by F. C. Root.

2973. From stock bought and sampled by W. C. Newton, Durham, from Coles & Weeks, Middletown.

2980. From stock bought and sampled by Meech & Stoddard, Middletown. From Butler, Breed & Co. of Boston. This sample is undecorticated, which explains the low per cent. of nitrogen. It will be referred to more particularly in the discussion of feeding stuffs.

	Analyses.					
	2658	**2722**	**2758**	**2864**	**2972**	**2980**
Nitrogen	6.44	6.89	6.74	7.42	5.63	3.67
Phosphoric Acid	3.34	3.12	3.22	3.10	3.27	1.60
Potash	1.96	2.22	2.16	1.62	1.80	1.45
Cost per ton	$22.00	$26.00	$23.00	$25.00	$27.00	....
Nitrogen costs per pound in cents,*	11.7	13.8	11.9	12.6	18.0	....

*Allowing 7c. and 6c. per pound respectively for phosphoric acid and potash.

Special attention is called to the last two analyses.

2973 is adulterated with rice meal which is harmless but reduces the value of the meal, either as a feed or fertilizer, by four or five dollars a ton. The color of the meal is rather lighter than pure meal, but the adulteration is not likely to be detected without microscopic or chemical examination.

Messrs. Coles & Weeks, from whom it was bought, state that they purchased it through a New York agent, and as a long time elapsed between the purchase and the sending to the Station for analysis the manufacturer of the fraud could not be traced. Messrs. Coles & Weeks expressed surprise at the result, as they had always ordered the best, and offered to make good the loss to the purchaser. Samples which are to be sent to the Station for analysis should be sent *at once.*

Cotton seed meal, of good quality, such as is used for cattle food, is one of the cheapest sources of available nitrogen in our fertilizer market, and that which is "off color" supplies nitrogen at even lower prices; in Nos. **2658** and **2758** for less than 12 cents per pound.

Castor Pomace.

The ground residue of castor beans from which castor oil has been extracted.

2714. Made by Occidental Oil Co., N. Y. Sold by L. Sanderson, New Haven. Sampled by E. F. Thompson, Warehouse Point.

2655. Made by Occidental Oil Co., N. Y. Sold by L. Sanderson, New Haven. Sampled by John Mason at Warehouse Point.

2656. Made by Collier Lead & Oil Co., St. Louis. Sold by F. Ellsworth, Hartford.

2932. Made by H. J. Baker & Bro., N. Y. Sold by W. F. Andross, East Hartford.

2933. Made by Red Seal Castor Oil Co., St. Louis, Mo. Sold by Olds & Whipple, Hartford.

ANALYSES.

	2714	2655	2656	2932	293
Nitrogen	4.70	4.93	5.65	5.08	5.4
Phosphoric acid	1.55	1.62	2.11	1.83	2.4
Potash	1.24	1.11	1.05	1.11	1.1
Cost per ton	$19.00	$19.00	$23.00	$21.00	$23.0
Nitrogen costs per pound in cents,*	16.3	15.6	16.6	16.8	16.

*Allowing 7c. and 6c. per pound respectively for phosphoric acid and potash.

The Castor Pomace furnished by the Occidental Oil Co. is ex ceptionally low in nitrogen [4.70–4.93 per cent.], but at $19.0 per ton, nitrogen costs no more than in the other brands sold a $23.00 per ton.

HOOF MEAL.

2805. A sample of this material, purchased in Chicago fo field experiments, contained 13.90 per cent. of nitrogen.

II. RAW MATERIALS OF HIGH GRADE CONTAINING PHOSPHORI ACID.

THOMAS-SLAG.

2730. Purchased by Lawrence Doyle, Harwinton, from P Weidinger, 76 Pine St., N. Y., for $16.00 per ton, f. o. b. N. Y Sampled by Mr. Doyle. The Slag contained 19.76 per cent. o phosphoric acid.

The phosphoric acid therefore costs 4 cents per pound.

DISSOLVED BONE BLACK.

A superphosphate prepared by treating bone black with oil o vitriol which renders nearly all of the phosphoric acid soluble i water.

2688. A single sample from stock of L. Sanderson, New Ha ven, had the following composition :—

ANALYSIS.

Soluble phosphoric acid	16.99
Reverted "	.13
Insoluble "	None
Cost per ton	$26.00
Available phosphoric acid costs per pound in cents.	7.6

PRECIPITATED PHOSPHATE.

2669. Made by the Cartaret Chemical Co., 115 Broadway, N. Y. Sampled and sent by the manufacturers.

ANALYSIS.

Soluble phosphoric acid	2.32
Reverted	28.52
Insoluble	6.53
Cost per ton	$33.63*
Available phosphoric acid costs per pound in cents	5.4

* Wholesale.

This waste product from the glue manufacture is a white powder, fine and dry, and contains a large per cent. of phosphoric acid which has been precipitated from solution by the addition of lime. It is sold on analysis, wholesale, at "90 cents per unit of phosphoric acid." A "unit" in the trade is 1 per cent. or 20 pounds per ton. As the sample contains 37.37 per cent. or "units" of phosphoric acid, the ton price would be $37.37 \times .90 =$ $33.63 at Newark, N. J., f. o. b.

Precipitated phosphate of lime is readily assimilable by vegetation and in many cases has proved quite as efficient as water-soluble phosphates and is considerably cheaper.

III. RAW MATERIALS OF HIGH GRADE CONTAINING POTASH.

DOUBLE SULPHATE OF POTASH AND MAGNESIA AND MURIATE OF POTASH.

The first named material is usually sold as "sulphate of potash" or "manure salt," on a guarantee of "48–50 per cent. sulphate," which is equivalent to 25.9–27 per cent. of actual potash. Besides some 46–50 per cent. of sulphate of potash it contains over 30 per cent. of sulphate of magnesia, chlorine equivalent to 3 per cent. of common salt, a little sulphate of soda and lime, with varying quantities of moisture.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride), 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water.

It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of actual potash.

2687. Sulphate of Potash. **2689.** Muriate of Potash; bot from stock of L. Sanderson, sampled by Station agent.

ANALYSES.

Potash	25.76	51.12
Cost per ton	$30.00	$42.50
Potash costs per pound in cents	5.8	4.2

IV. Raw Materials Containing Nitrogen and Phosphori Acid.

Bone Manures.

The terms "Bone Dust," "Ground Bone," "Bone Meal" an "Bone" applied to fertilizers, sometimes signify material mad from dry, clean and pure bones; in other cases these terms refe to the result of crushing fresh or moist bones which have bee thrown out either raw or after cooking, with more or less mea tendon, and grease—and if taken from garbage heaps, with ashe or soil adhering; again they denote mixtures of bone, blood, mea and other slaughter-house refuse which have been cooked i steam-tanks in order to recover grease, and are then dried an sometimes sold as "tankage;" or, finally, they apply to bone fro which a large share of the nitrogen has been extracted in th glue manufacture. The nitrogen of all these varieties of bon when they are in the same state of mechanical subdivision ha essentially the same fertilizing value.

1. *Sampled by Station Agents.*

On pages 29 to 31 will be found tabulated analyses belong ing to this class. Excluding **2934** and **2931,** which are mixture of bone and potash, and **2928,** which is a mixture of bone an salt cake, the average cost of the other 19 samples of bone ha been $33.00 and the average valuation $37.77. The values use by the Station in the valuation of bone this year have beer therefore, too high by about 10 per cent.

Bone Manures.—Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost per ton.
2720	Pure Ground Bone.	----------	L. Sanderson, New Haven.	$33.00
2924	Pure Bone Meal.	Peter Cooper's Glue Factory, N. Y.	Wilson & Burr, Middletown.	28.00
2811	Bone Fertilizer.	Plumb & Winton, Bridgeport, Conn.	Manufacturers.	30.00
2934	Self-Recommending Fertilizer.	F. Nuhn, Waterbury, Conn.	City Coal & Wood Co., New Britain.	33.00
2962	Pure Ground Bone.	Peck Bros., Northfield, Conn.	Manufacturers.	28.00
3004	Swift Sure Bone Meal.	M. L. Shoemaker & Co., Philadelphia, Pa.	F. Ellsworth, Hartford.	40.00
			J. P. Barstow & Co., Norwich.	38.00
			F. S. Bidwell, Windsor Locks.	32.00
2681	Pure Ground AX Bone.	Rogers & Hubbard Co., Middletown.	Manufacturer.	32.00
2683	Raw Knuckle Bone Flour.	Rogers & Hubbard Co., Middletown.	Manufacturer.	37.00
2918	Ground Bone.	Quinnipiac Co., New London.	J. F. Ellwood, Southport.	31.00
			G. M. Williams, New London.	35.00
			A. P. Wakeman, Fairfield.	----
2682	Strictly Pure Fine Bone.	Rogers & Hubbard Co., Middletown.	Manufacturer.	34.00
2926	Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Olds & Whipple, Hartford.	35.00
			J. A. Lewis, Willimantic.	34.00
			J. P. Barstow & Co., Norwich.	34.00
2921	Fine Ground Bone.	H. J. Baker & Bro., 215 Pearl St, N. Y.	C. O. Jelliff & Co., Southport.	31.00
2927	Ground Bone.	Downs & Griffin, Birmingham.	Manufacturer.	30.00
2917	Chittenden's Ground Bone.	National Fertilizer Co., Bridgeport.	D. H. Leonard, Leonard's Bridge.	----
			T. E. Eldridge, Norwich.	33.00
			E. P. Matherson, Pomfret.	33.00
			J. H. French, Cheshire.	**34.00**

Bone Manures.—Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Cost per ton.
2923	Pure Fine Ground Bone.	Bradley Fertilizer Co., 27 Kilby St, Boston, Mass.	Waterbury & June, Greenwich.	----
			W. B. Martin, Rockville.	$35.00
			R. A. Parker, Warehouse Point.	36.00
			Burtis & Mead, New Canaan.	37.00
			G. Dickinson, Haddam.	35.00
2923	Pure Ground Bone.	G. W. Miller, Middlefield, Conn.	W. H. Cheney's Sons, So. Manchester.	35.00
			Manufacturer.	30.00
2920	Ground Bone.	H. S. Miller & Co., Newark, N. J.	Southington Lumber & Feed Co., Southington.	30.00
			J. P. Bolan, Waterbury.	34.00
			Staples & Raymond, Westport.	35.00
			H. K. Brainard, Thompsonville.	28.00
2930	Pure Ground Bone.	Williams & Clark Fertilizer Co., N. Y.	Daniel Morgan, Poquonock.	35.00
			W. E. Payne, Rockville.	35.00
2931	Ground Bone.	E. Frank Coe., 16 Burling Slip, N. Y.	Arnold Rudd, New London.	30.00
			Simon Banks, Southport.	28.00
2925	Pure Ground Bone.	Crocker Fertilizer Co., Buffalo, N. Y.	J. S. Wells, Hebron.	38.00
2922	Fresh Ground Bone.	Bowker Fertilizer Co., 43 Chatham St, Boston, Mass.	Hull & Sweet, South Coventry.	35.00
			H. F. Porter, Hebron.	34.00
			J. A. Lewis, Willimantic.	34.00
2928	Lister's Celebrated Ground Bone.	Lister's Agricultural Chemical Works, Newark, N. J.	A. N. Clark, Milford.	28.00

Station No.	Name or Brand.	Chemical Analysis.		Mechanical Analysis.					Cost per ton.	Valuation per ton.	Percentage difference between cost and valuation.
				Finer than				Coarser than			
		Nitrogen.	Phos. Acid.	$\frac{1}{50}$ inch.	$\frac{1}{35}$ inch.	$\frac{1}{18}$ inch.	$\frac{1}{6}$ inch.	$\frac{1}{6}$ inch.			Valuation exc'ds cost.
2720	Sanderson's Pure Ground Bone	3.61	25.38	74	23	3	--	--	$33.00	$45.26	27.1
2924	Peter Cooper's Bone Dust	2.01	28.07	41	15	22	22	--	28.00	37.47	25.3
2811	Plumb & Winton's Bone Fertilizer	4.37	20.61	53	22	17	8	--	30.00	37.86	20.8
2934	Nuhn's Self-Recommending Fertilizer	3.99	*22.09	65	20	9	6	--	32.50	40.76	20.2
2962	Peck Bros.' Pure Ground Bone	4.13	21.15	30	27	28	15	--	28.00	34.67	19.2
3004	Shoemaker's Swift Sure Bone Meal	6.00	21.95	63	28	9	--	--	40.00	49.33	18.9
2681	Rogers & Hubbard Co's Pure Ground AX Bone	4.08	22.52	45	24	28	3	--	32.00	38.73	17.4
2683	Rogers & Hubbard Co's Raw Knuckle Bone Flour	3.85	25.45	72	28	--	--	--	37.00	44.60	17.0
2918	Quinnipiac Ground Bone	3.16	24.51	53	22	20	5	--	33.00	39.47	16.4
2682	Rogers & Hubbard Co's Strictly Pure Fine Bone	4.00	22.93	52	29	19	--	--	34.00	40.51	16.0
2926	Darling's Ground Bone	2.69	24.26	71	19	10	--	--	34.00	40.27	15.5
2921	Baker's Fine Ground Bone	3.81	24.27	48	34	18	--	--	31.00	36.57	15.2
2927	Downs & Griffin's Ground Bone	4.51	23.05	17	20	44	19	--	30.00	35.15	14.6
2917	Chittenden's Ground Bone	3.08	25.13	44	20	20	16	--	33.00	37.96	13.1
2923	Bradley's Pure Fine Ground Bone	3.62	22.81	58	30	12	--	--	35.00	40.13	12.8
2929	G. W. Miller's Pure Ground Bone	4.07	22.53	18	16	27	39	--	30.00	32.24	6.9
2920	H. S. Miller's Ground Bone	2.29	22.73	49	18	22	11	--	32.00	33.77	5.2
2930	Williams & Clark's Pure Bone Meal	2.83	23.95	42	23	23	12	--	35.00	36.06	2.9
											Cost exc'ds valuation.
2931	E. Frank Coe's Ground Bone	2.08	†18.75	35	20	21	24	--	29.00	27.67	1.2
2925	Crocker's Pure Ground Bone	4.37	23.69	23	25	34	18	--	38.00	36.82	3.2
2922	Bowker's Fresh Ground Bone	3.02	20.12	31	26	32	11	--	34.00	30.95	9.8
2928	Lister's Ground Bone	2.90	14.34	43	20	19	18	--	28.00	24.53	14.1

* Also contains .64 per cent. of Potash and .90 per cent. of Chlorine.

† Also contains 1.33 per cent. of Potash.

2. *Manufacturers' Samples and Samples Sent by Purchasers.*

3002. Ground Bone, made by E. B. Fall, Middletown.

2642. Ground Bone, made by F. Nuhn, Waterbury. Sampled and sent by John Spear, Cheshire.

2741. Self-Recommending Fertilizer, made by F. Nuhn, Waterbury. Sampled and sent by E. Davis, Hamden.

3054. Bone Sawdust, made by Salisbury Cutlery Co. Sampled and sent by T. A. Stanley, New Britain. Cost $40.00 per ton f. o. b. in Springfield, Mass.

ANALYSES.

	3002.	2642.	2741.	3054.
Fine, smaller than $\frac{1}{60}$ inch	52	59	68	100
Fine medium, smaller than $\frac{1}{25}$ inch	25	20	14	0
Medium, smaller than $\frac{1}{13}$ inch	20	16	10	0
Coarse, larger than $\frac{1}{13}$ inch	3	5	8	0
	100	100	100	100
Nitrogen	1.85	3.96	3.77	3.96
Phosphoric Acid	28.53	21.26	19.84	26.29
Potash	---	---	3.93	---
Valuation per ton	$40.97	$38.33	$40.14	$49.88

2675. Bone and Potash, home mixed. Sampled and sent by C. Buckingham, Southport.

2751. Bone ground at a grist mill and sent for analysis by E. M. Spalding, Suffield.

3055. Fish Scrap and Potash Salts, made by G. W. Miles, Milford. Sampled and sent by W. L. and S. T. Merwin, Milford.

	2675.	2751.	3055.
Nitrogen	3.23	3.31	4.32
Phosphoric Acid	13.19	17.45	3.64
Potash	6.86	----	2.53
Cost per ton	$35.00	$30.00	$20.00
Valuation	$34.34	$27.17	$22.06

84 per cent. of the mixture **2675** passed a $\frac{1}{25}$ inch sieve. Only 14 per cent. of **2751** passed a $\frac{1}{25}$ inch sieve and a half of it was larger than $\frac{1}{13}$ inch.

Tankage.

This name is properly applied only to the sediment remaining in tanks where meat scrap with some bone is rendered to separate the fat. After boiling or superheating with steam, the fat rises to the surface of the water and is removed, the soup is run off, and the settlings at the bottom are dried and sold as tankage. Such material contains as large or larger percentage of nitrogen than of phosphoric acid. But the name tankage is also loosely applied to mixtures that consist largely of bone and do not differ greatly in composition from pure bone.

2686. Pulverized Tankage [Bone and Meat]; **2722,** Tankage; **2749,** Blood, Bone and Meat. All from stock of L. Sanderson, New Haven.

2750. Blood, Bone and Meat, made by F. S. Andrew & Co., New Haven. Sampled and sent by M. Wooding, Highwood.

2972. Tankage, made by Strong, Barnes, Hart & Co., New Haven. Sampled and sent by W. C. Newton, Durham.

Mechanical Analyses.

	2686	2722	2749	2750	2972
Fine, smaller than $\frac{1}{8}$ inch	96	42	51	19	47
Fine medium, smaller than $\frac{1}{4}$ inch	4	22	18	17	21
Medium, smaller than $\frac{1}{2}$ inch	--	25	19	26	14
Coarse, larger than $\frac{1}{2}$ inch	--	11	12	38	18
	100	100	100	100	100

Chemical Analyses.

	2686	2722	2749	2750	2972
Nitrogen	5.03	3.26	7.35	4.00	6.96
Phosphoric Acid	19.32	8.75	12.69	17.09	9.94
Cost per ton	$35.00	$35.00	$35.00	$20.00	$22.00*
Valuation per ton	43.36	32.46	35.67	24.87	32.03

*In 5 ton lots f. o. b., New Haven.

Mixed Fertilizers.

I. Nitrogenous Superphosphates and Guanos.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid and in most cases potash, which are not designed by their manufacturers for use on any special crop. "Special Manures" are noticed further on. Fish scrap is here included as it is sometimes acidulated with oil of vitriol to preserve it, thus making it a nitrogenous superphosphate.

1. *Samples drawn by Station Agents.*

In the tables on pages 37 to 47 are given sixty-five analyses of this kind.

After the name of a brand the names of a number of dealers are frequently given. This indicates that a sample of this brand was drawn by our agent from each dealer named and that the corresponding analysis was made on a mixture of equal parts of all these samples.

The Station assumes full responsibility for accuracy of sampling and analysis only on such samples as are drawn by its own agents. On samples drawn by other persons the Station holds itself responsible only for the accuracy of analysis, but requires before making an analysis a formal statement that the person who drew the sample did it in accordance with the Station directions. A blank form of this statement is furnished on application.

The prices quoted are dealers' *cash ton* prices.

These prices quoted by different dealers for the same fertilizers differ in some cases considerably, partly on account of difference in freight-rates, presence or absence of competition, etc. Some manufacturers claim that their goods are sold at a uniform price at all points in the state, but usually the price charged is fixed by the dealer.

The last column of the table of analyses is "Percentage Difference between Cost and Valuation." Its significance and the method of calculating it may be seen by noticing the first analysis in the table on page 45, No. **2795**. Here the cost is $36,

the valuation is $32.02, and the difference between them is $3.98. By multiplying this difference, $3.98, by 100, and dividing it by the valuation, $32.02, we get 12.4. the percentage advance of selling price over valuation, which advance should represent on the average the costs and profits of the manufacturer in converting the raw materials into a mixed fertilizer, selling it and collecting on his sales.

DIFFERENCE BETWEEN COST AND VALUATION.

In five cases the valuation exceeded the cost.

Leaving out of account the last three analyses in the tables in which the cost exceeded valuation by considerably more than 50 per cent. the average cost of 62 Nitrogenous Superphosphates was $33.80 and the average valuation $28.57. The difference is $5.23, and the percentage difference 18.3.

That is, the same quantities of nitrogen, phosphoric acid and potash, which were contained in an average ton of Nitrogenous Superphosphate could have been bought in raw materials of standard quality in ton lots in this State for $28.57 cash, in the average Superphosphate they cost $33.80, and hence the manufacturers' and dealers' expenses and profits on a ton of fertilizer averaged $5.23, or 18.3 per cent. of the cost of the materials.

Guarantees.—The analyses of 23 superphosphates out of the 65 show that their composition is below the maker's minimum guarantee in one or more particulars. Twenty-two, or more than one-third of the whole number, are deficient in one ingredient, and two others in two ingredients.

It is required, under the law, that the quantity of *actual* potash shall be expressly stated. "Potash, Sulphate, 4 per cent." means four per cent of *actual potash* in the form of sulphate, and not 2.16 per cent. of potash, but the expression is often used by manufacturers, when only the smaller quantity of actual potash is present in the fertilizer. Such use is deceptive.

Fish and Potash.—The analyses of material bearing this designation, though included among nitrogenous superphosphates are also tabulated by themselves on the next page. Most of the brands are not simple mixtures of fish scrap and potash salts, as the name would imply, but contain in some cases considerable quantities of added phosphates.

Fish and Potash—Sampled by the Station.

	Kelsey's.	Bowker's.	Chittenden's.	Quinnipiac Plain Brand.	Bradley's Anchor Brand.	Read's.	Church's.	Quinnipiac Crossed Fishes Brand.	Bradley's Triangle A.	Farmer's.	E. F. Coe's.
	2828	2839	2793	2876	2852	2892	2907	2875	2851	2831	2856
Nitrogen as Ammonia	.78	----	.96	.56	----	----	.30	.78	.62	----	----
Nitrogen, Organic	3.24	2.54	2.92	2.25	3.76	2.78	2.96	3.02	2.00	1.69	2.21
Soluble Phosphoric Acid	2.56	5.95	1.31	1.60	4.76	3.52	1.55	1.12	3.25	4.26	.51
Reverted Phosphoric Acid	3.16	1.99	4.37	3.31	1.84	2.46	2.71	3.79	1.60	2.33	3.75
Insoluble Phosphoric Acid	.68	4.42	3.10	3.00	1.36	1.73	.88	3.57	1.35	1.25	4.60
Potash	3.51	4.15	5.05	5.22	2.67	4.96	3.89	4.41	3.99	7.42	3.10
Cost	$27.00	32.50	33.00	28.00	32.00	30.00	28 00	34.00	30.00	34.00	29.50
Valuation	$26.65	28.68	28.26	23.59	26.39	24.28	21.67	26.51	20.91	23.50	19.56

Nitrogenous Superphospates and Guanos Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2909	Dry Ground Fish Guano.	Leander Wilcox, Mystic Bridge.	C. M. Smith, E. Hartford.	------
2879	Acidulated Fish Guano.	Leander Wilcox, Mystic Bridge.	C. M. Smith, E. Hartford.	$22.00
2919	Dry Ground Fish.	Quinnipiac Co., New London.	Olds & Whipple, Hartford.	36.00
2908	Pure Dry Fish.	Joseph Church & Co., Tiverton, R. I.	H. K. Brainard, Thompsonville.	36.00
2748	Sanderson's Formula, A. A.	L. Sanderson, New Haven.	J. J. Merwin, Orange.	36.00
2891	Flour of Bone Phosphate.	G. W. Miller, Middlefield.	Manufacturer.	35.00
2828	Fish and Potash.	E. R. Kelsey, Branford.	Wilson & Burr, Middletown.	28.00
			Miles Payne, Cheshire.	25.00
2880	Swift Sure Superphosphate.	M. L. Shoemaker & Co., Phila., Pa.	J. P. Barstow & Co., Norwich.	37.00
			F. Ellsworth, Hartford.	38.00
2857	Ammoniated Bone Superphosphate.	Russell Coe, Tremley, N. J.	City Coal and Wood Co., New Britain.	30.00
			Wilson & Burr, Middletown.	30.00
			S. J. Hall, Meriden.	32.00
2904	Harvest Queen Phosphate.	H. S. Miller & Co., Newark, N. J.	J. O. Fox, Putnam.	25.00
			H. K. Brainard, Thompsonville.	28.00
2874	Market Garden Manure.	Quinnipiac Co., New London.	E. B. Clark, Milford.	39.00
			J. F. Elwood, Southport.	41.00
2802	Standard or Success Fertilizer.	Lister's Agricultural Chemical Works, Newark, N. J.	J. A. Lewis, Willimantic.	28.00
			A. N. Clark, Milford.	25.00
			J. H. Fish, Newington.	30.00
2823	Ammoniated Bone Phosphate.	Lister's Agricultural Chemical Works, Newark, N. J.	Edw. Carroll, E. Hartford.	37.00
			A. N. Clark, Milford.	28.00
			G. T. Fowler, Branford.	28.00
2873	Cumberland Superphosphate.	Cumberland Bone Co., Portland, Me.	Haley & Cheseboro, Stonington.	35.00
			H. H. Davenport, Putnam.	34.00
2761	Pine Island Phosphate.	Quinnipiac Co., New London.	J. E. Leonard, Jewett City.	32.00
			John Taylor, Old Mystic.	37.00
			Olds & Whipple, Hartford.	35 00
			B. E. Johnson, Higganum.	32.00
			E. B. Clark, Milford.	30.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2795	Complete Manure, A Brand.	Mapes' Formula and Peruvian Guano Co., N. Y.	Mapes' Branch, Hartford.	$36.00
			Wilson & Burr, Middletown.	36.00
			J. P. Barstow & Co., Norwich.	36.00
2839	Fish and Potash.	Bowker Fertilizer Co., 43 Chatham Street, Boston, Mass.	F. Hallock & Co., Birmingham.	35.00
2765	A. A. Ammoniated Bone Superphosphate.	H. J. Baker & Bro., 215 Pearl St., N. Y.	W. W. Cooper, Suffield.	37.50
			A. L. Winton, Bridgeport.	37.50
			M. F. Gregory & Co., Milford.	38.00
			W. F. Andross, E. Hartford.	37.50
2797	Complete Manure for General Use.	Mapes' Formula and Peruvian Guano Co., N. Y.	Mapes' Branch, Hartford.	39.00
			W. H. Childs, Manchester.	39.00
			Dean & Horton, Stamford.	40.00
2766	Ammoniated Bone Phosphate.	National Fertilizer Co., Bridgeport.	N. C. Barker, Lebanon.	33.00
			G. H. & H. B. Williams, E. Hartford.	32.00
			T. E. Eldridge, Norwich.	------
			S. W. Currier, Bridgeport.	35.00
			E. B. Clark, Milford.	30.00
2822	Farmers' New Method Fertilizer.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Warren, Clark & Taylor, Sandy Hook.	32.00
			J. E. Leonard, Jewett City.	32.00
			Prentiss & Young, Norwich.	32.00
			D. N. Clark & Sons, Milford.	30.00
			W. J. Starr, Groton.	34.00
			G. R. Fowler, Central Village.	34.00
			F. S. Bidwell, Windsor Locks.	30.00
			Carter & Strong, Manchester.	34.00
			Wilson & Burr, Middletown.	34.00
			G. W. Carver, Putnam.	29.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2800	Darling's Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	R. P. Hubbard, Middletown.	$36.00
			F. S. Bidwell, Windsor Locks.	35.00
			J. P. Barstow & Co., Norwich.	35.00
2798	Complete Manure for Light Soils.	Mapes' Formula and Peruvian Guano Co., N. Y.	Mapes' Branch, Hartford.	44.00
			G. K. Nason, Willimantic.	45.00
			Wilson & Burr, Middletown.	44.00
2762	Ammoniated Bone Superphosphate, Americus Brand.	Williams & Clark Fertilizer Co., 81 Fulton St., N. Y.	Dix & Wells, Wethersfield.	35.00
			Daniel Morgan, Poquonock.	35.00
			J. E. Roode, Jewett City.	36.00
			C. L. Backus, Andover.	----
			Charles Stagg, Stratford.	35.00
			L. N. Dimmock, New London.	35.00
			Abbott & Co., Birmingham.	40.00
			F. S. Bidwell, Windsor Locks.	34.00
			H. K. Brainard, Thompsonville.	35.00
			J. P. Little, Columbia.	36.00
2793	Chittenden's Fish and Potash.	National Fertilizer Co., Bridgeport.	G. H. & H. B. Williams, E. Hartford.	32.00
			N. C. Barker, Lebanon.	33.00
			T. E. Eldridge, Norwich.	34.00
2876	Fish and Potash, Plain Brand.	Quinnipiac Co., New London.	A. J. Martin, Wallingford.	28.00
			B. E. Johnson, Higganum.	31.00
2760	Quinnipiac Phosphate.	Quinnipiac Co., New London.	J. P. Little, Columbia.	36.00
			G. M. Williams, New London.	37.00
			D. C. Wood, Stratford.	37.00
			J. S. Worthington, Portland.	36.00
			Olds & Whipple, Hartford.	38.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2815	Ammoniated Bone Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. E. Leonard, Jewett City.	$32.00
			N. E. Smith, Woodmont.	30.00
			E. B. Clark, Milford.	30.00
			W. B. Martin, Rockville.	34.00
2976	Standard Bone Superphosphate.	H. S. Miller & Co., Newark, N. J.	Staples & Raymond, Westport.	35.00
			Southington L. & F. Co., Southington.	34.00
			A. Williams, Collinsville.	35.00
2841	Sea Fowl Guano.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	W. W. Cooper, Suffield.	36.00
			F. S. Bidwell, Windsor Locks.	32.00
2882	Royal Bone Phosphate.	Williams & Clark Fertilizer Co., 81 Fulton St., N. Y.	Hale, Day & Co., South Manchester.	28.00
			F. S. Bidwell, Windsor Locks.	30.00
2852	Fish and Potash, Anchor Brand.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	H. J. Morse, Cheshire,	32.00
			R. A. Parker, Warehouse Point.	32.00
2820	Bradley's Patent Superphosphate of Lime.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	N. C. Barker, Lebanon.	36.00
			W. J. Starr, Groton.	37.00
			D. Beers, Danbury.	38.00
			J. E. Leonard, Jewett City.	36.00
			Burtis & Mead, New Canaan.	38.00
			D. N. Clark & Sons, Milford.	34.00
			E. B. Clark, Woodmont.	37.00
			Warren, Clark & Taylor, Sandy Hook.	36.00
			E. E. Scofield, Stamford.	34.00
			J. E. Holmes, Stratford.	37.00
			Wheeler & Howe, Bridgeport.	37.00
			Raymond Bros., South Norwalk.	36.00
			Prentiss & Young, Norwich.	36.00
			G. A. Dickinson, Haddam.	36.00
			G. R. Fowler, Central Village.	----
			Carter & Strong, Manchester.	38.00
			Dix & Wells, Wethersfield.	35.00
			Wilson & Burr, Middletown.	35.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2820	Bradley's Patent Superphosphate of Lime.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	J. A. Lewis, Willimantic.	$36.00
			R. A. Parker, Warehouse Point.	34.00
			Quinnebaug Store, Danielsonville.	36.00
			W. B. Martin, Rockville.	36.00
			W. H. Cheney's Sons, S. Manchester.	38.00
			W. F. Andross, East Hartford.	36.00
			A. C. Sternberg, Hartford.	35.00
			G. W. Carver, Putnam.	35.00
			H. D. Lanphear, Chaplin.	36.00
			F. S. Bidwell, Windsor Locks.	34.00
2768	High Grade Phosphate.	E. Frank Coe, 16 Burling Slip, N. Y.	N. C. Barker, Lebanon.	34.00
			I. W. Denison & Co., Mystic.	33.00
			Wheeler & Howe, Bridgeport.	35.00
			Backus Bros., South Windham.	34.00
			F. P. Burr & Co., Middletown.	35.00
			Arnold Rudd, New London.	33.00
			J. P. Barstow & Co., Norwich.	32.00
			J. A. Amidon, Wethersfield.	33.00
2800	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport.	G. H. & H. B. Williams, E. Hartford.	42.00
			D. Fitzgerald, Stratford.	42.00
			D. G. Penfield, Danbury.	42.50
2833	Reese's New England Favorite.	J. S. Reese & Co., New Bedford, Mass.	Ansell Arnold & Co., Willimantic.	29.00
2813	Clark's Cove Bay State Fertilizer, G. G.	J. S. Reese & Co., Licensee, New Bedford, Mass.	Ansell Arnold & Co., Willimantic.	28.50
			H. H. Davenport, Pomfret.	32.00
			W. Tillinghast, Plainfield.	37.50
2889	Victor Phosphate.	Apothecaries Hall Co., Waterbury.	Manufacturer.	30.00
2892	Bone, Fish and Potash.	Read Fertilizer Co., N. Y.	W. F. Andross, East Hartford.	30.00
			H. E. Ives, Cheshire.	30.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2803	Hill and Drill Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Hull & Sweet, South Coventry.	$38.00
			C. H. Bell, Portland.	38.00
			J. H. Ives, Danbury.	38.00
			C. T. Leonard, Norwalk.	38.00
			B. Curtis & Son, Stepney.	40.00
			W. B. Martin, Rockville.	37.00
			J. H. Fish, Newington.	36.00
2905	Olds & Whipple's Special Phosphate.	Made for Dealer.	Olds & Whipple, Hartford.	35.00
2910	IXL Phosphate.	G. W. Miles, Milford.	A. H. Hinckley, Old Mystic.	30.00
2842	Original Coe's Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	F. S. Bidwell, Windsor Locks.	33.00
2835	Soluble Pacific Guano.	W. D. Stewart & Co., Boston, Mass.	P. J. Bolan, Waterbury.	34.00
			W. F. Andross, East Hartford.	36.00
			City Coal and Wood Co., New Britain.	36.00
2974	Dissolved Bone Phosphate.	H. S. Miller & Co., Newark, N J.	Staples & Raymond, Westport.	32.00
			A. Williams, Collinsville.	32.00
2907	Fish and Potash.	Joseph Church & Co., Tiverton, R. I.	H. K. Brainard, Thompsonville.	28.00
2875	Fish and Potash, Crossed Fishes Brand.	Quinnipiac Co., New London.	Olds & Whipple, Hartford.	37.00
			B. E. Johnson, Higganum.	34.00
			J. F. Silliman, New Canaan.	38.00
			A. L. Martin, Wallingford.	34.00
			J. P. Little, Columbia.	35.00
2807	Pilgrim Fertilizer.	J. S. Reese & Co., New Bedford, Mass.	Ansell Arnold & Co., Willimantic.	24.00
2854	Clark's Cove Company's King Philip Alkaline Guano.	J. S. Reese & Co., Licensees, New Bedford, Mass.	Ansell Arnold & Co., Willimantic.	24.65
			H. H. Davenport, Pomfret.	30.00
2829	Cecrops Fertilizer.	F. Ludlam, 140 Maiden Lane, N. Y.	Ahlquist & Allison, Portland.	38.00
			C. H. Cleveland, Brooklyn.	42.00
2830	Farmers' Friend Fertilizer.	Read Fertilizer Co., N. Y.	W. F. Andross, East Hartford.	35.00
			R. P. Hubbard, Middletown.	34.00
			H. E. Ives, Cheshire.	35.00

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2827	Cereal Fertilizer.	F. Ludlam, 140 Maiden Lane, N. Y.	W. J. Starr, Groton.	$32.00
			W. Tillinghast, Plainfield.	32.00
			Ahlquist & Allison, Portland.	32.00
			C. A. Young, Danielsonville.	31.00
			C. H. Cleveland, Brooklyn.	32.00
2799	Ammoniated Bone Superphosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	L. Browning, New London.	37.00
			Dix & Wells, Wethersfield.	35.00
			L. L. Herman, Noroton.	35.00
			J. E. Leonard, Jewett City.	36.00
			Haley & Cheeseboro, Stonington.	45.00
2825	Lion Brand Fertilizer.	Read Fertilizer Co., N. Y.	R. P. Hubbard, Middletown.	30.00
			W. Tillinghast, Plainfield.	33.00
			H. E. Ives, Cheshire.	32.00
			W. F. Andross, East Hartford.	32.00
2796	New Rival Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	L. L. Herman, Noroton.	32.00
			L. Browning, New London.	35.00
			J. A. Lewis, Willimantic.	30.00
2890	Peruvian Guano. Cargo C R. Lewis.	Mapes' Formula and Peruvian Guano Co., 158 Front St., N. Y., Importers.	Mapes' Branch, Hartford.	62.00
2855	Alkaline Bone Phosphate.	E. Frank Coe, 16 Burling Slip, N. Y.	Backus Bros., South Windham.	34 00
			H. S. Hall, (2d) Wallingford.	35.00
851	Triangle A, Fish and Potash.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Burtis & Mead, New Canaan.	33.00
			Raymond Bros., South Norwalk.	30.00
2831	Fish and Potash.	Farmers' Fertilizer Co., Syracuse, N. Y.	A. C. Sternberg, Hartford.	34.00
2856	High Grade Fish and Potash.	E. Frank Coe, 16 Burling Slip, N. Y.	W. T. Andrews, Orange.	29.00
			F. P. Burr & Co., Middletown.	30.00
2895	Davidge Vegetator.	Davidge Fertilizer Co., 121 Front St., N. Y.	J. M. Burke, South Manchester.	35.00
2894	Ammoniated Bone Superphosphate.	Stearns Fertilizer Co., 181 Front St., N. Y.	R. P. Hubbard, Middletown.	34.00
2832	Standard Special Formula.	Farmers' Fertilizer Co., Syracuse, N. Y.	W. H. Childs, Manchester.	32.00
2872	Economical Bone Fertilizer.	Wilkinson & Co., 54 William St., N. Y.	R. H. Coley, Southport.	32.00

Analyses of Nitrogenous Superphosphates Sampled by the Station.

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.					
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.	Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
2909	Wilcox's Dry Ground Fish Guano	....	...	8.61	8.61	*8.0*	.93	4.20	1.93	7.06	....	5.13	*4.0*	...	....	....	$32.00	$38.23	16.3*
2879	Wilcox's Acidulated Fish Guano	....	.97	4.59	5.56	*5.5*	1.76	2.72	.47	4.95	....	4.48	*4.0*	....	....	....	22.00	26.09	15.7*
2919	Quinnipiac Dry Ground Fish	....	....	9.26	9.26	*7.5*	81	3.60	2.43	6.84	....	4.41	*4.0*	....	....	....	36.00	39.64	9.2*
2908	Church & Co.'s Pure Dry Fish	....	....	8.84	8.84	*8.2*	.72	4.26	2.71	7.69	....	4.98	*6.8*	....	....	....	47.50 36.00	47.60 39.23	3.4* 8.2*
2748	Sanderson's Formula, A. A.	2.33	....	2.14	4.47	*3.3*	4.40	2.64	.74	7.78	*10.0*	7 04	*6.0*	8.64	*6.0*	2.26	35.00	34.96	0.1
2891	G. W. Miller's Flour of Bone Phosphate	1.12	.21	3.33	4.66	*4.0*	....	....	....	12.60†	*9.0*	....	....	4.92	*4.1*	3.98	35.00	34.63	5.1 1.0
2828	Kelsey's Fish and Potash	...	,78	3.24	4.02	*3.3*	2.56	3.16	.68	6.40	*4.0*	5.72	....	3.51	*3.0*	1.21	27.00	26.65	1.0
2880	Shoemaker's Swift Sure Superphosphate	.57	....	2.57	3.14	*2.5*	8.03	3.86	3.54	15.43	....	11.89	*9.0*	4.87	*4.0*	.32	37.50	36.87	1.7
2857	Russell Coe's Ammoniated Bone Phosphate	....	....	2.82	2.82	*1.7*	6.08	2.70	1.07	9.85	*10.0*	8.78	*8.0*	4.58	*2.0*	4.67	30.00	28.13	6.6
2904	H. S. Miller's Harvest Queen Phosphate	....	....	1.71	1.71	*.8*	6.14	2.69	1.11	9.94	....	8.83	*10.0*	2.61	*1.5*	.30	25.00	23.36	7.0
2874	Quinnipiac Market Garden Manure	.59	1.18	1.80	3.57	*3.3*	4.70	5.66	.86	11.22	....	10.36	*8.0*	7.05	*7.0*	.42	40.00	36.66	9.1
2802	Lister's Standard or Success Fertilizer	....	....	2.03	2.03	*1.0*	7.36	2.79	2.17	12.32	....	10.15	*10.0*	1.37	*1.3*	.52	28.00	25.61	9.3
2823	Lister's Ammoniated Bone Phosphate	....	....	2.05	2.05	*1.8*	7.05	2.51	2.47	12.03	....	9.56	*9.0*	1.56	*1.5*	.18	28.00	25.31	10.6
2873	Cumberland Superphosphate	.31	....	2.13	2.44	*2.0*	6.24	6.48	2.12	14.84	*12.0*	12.72	....	1.96	*2.0*	.78	34.50	31.17	10.7
7261	Quinnipiac Pine Island Phosphate																		

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
2795	Mapes' *Complete* Manure, A Brand	.35	.72	1.90	2.97	*2.5*	7.39	4.28	1.83	13.50	*12.0*	11.67	*10.0*	3.05	*2.5*	3.61	$36.00	$32.02	12.4
2829	Bowker's Fish and Potash	....	....	2.54	2.54	*2.3*	5.95	1.99	4.42	12.36	*8.0*	7.94	....	4.15	*4.0*	.27	32.50	28.68	13.3
2765	Baker's A.A. Ammoniated Bone Superphosphate	....	1.98	.86	2.84	*2.5*	11.14	1.65	.36	13.15	....	12.79	*10.0*	3.00	*2.0*	2.72	37.50	32.87	14.1
2797	Mapes' Complete Manure for General Use	.92	.64	2.17	3.73	*3.3*	7.16	3.68	2.02	12 86	....	10.84	*10.0*	4.17	*4.0*	3.51	39.00	34.17	14.1
2766	National Fertilizer Co 's Ammoniated Bone Phosphate	....	....	2.63	2 63	*1.7*	7.26	3.00	.78	11.04	*9.0*	10.26	*7.0*	2.57	*2.0*	1.18	32.50	28.14	15.5
2822	Bradley's Farmers' New Method Fertilizer	...	....	2.31	2.31	*1.6*	7.74	2.72	1.30	11.76	*10 0*	10.46	*8.0*	2.88	*3.0*	2.79	32.00	27.70	15.5
2860	Darling's Animal Fertilizer	....	.41	2.80	3.21	*3.3*	3.90	4.21	3.40	11.51	*10 0*	8.11	....	5.29	*4.0*	4.09	35.00	20.28	15.6
2798	Mapes' Complete Manure for Light Soil	1.54	1.44	2.37	5.35	*4.9*	4.96	3.31	2.03	10.30	*8.0*	8.27	*7.0*	7.05	*6.0*	6.70	44 00	37.91	16.1
2762	Williams & Clark's Ammoniated Bone Superphosphate, Americus Brand	.16	.68	1.94	2.78	*2.0*	7.47	4.34	.62	12.43	*11.0*	11.81	*10.0*	1.99	*2.0*	2.00	35.00	29.99	16.7
2792	Chittenden's Fish and Potash	....	.96	2.92	3.88	*3.3*	1.31	4.37	3.10	8.78	*6.0*	5.68	....	5.05	*5.0*	4.95	33.00	28.26	16.8
2876	Quinnipiac Fish and Potash, Plain Brand	....	.56	2.25	2.81	*2.0*	1.60	3.31	3.00	7.91	*6.0*	4.91	*4.0*	5.22	*4.0*	4 97	28.00	23.59	18.7
2760	Quinnipiac Phosphate	.29	.51	1.93	2.73	*2.5*	4.46	7.50	1.42	13.38	....	11.96	*9.0*	1.90	*2.0*	2.40	36.00	30.08	19.7
2815	Bowker's Ammoniated Bone Phosphate	.43	....	1.81	2.24	*2.0*	6.29	3.25	3.33	12.87	*10.0*	9.54	*8.0*	2.19	*2.0*	2.74	31.50	26.32	19.7
2976	Miller's Standard Superphosphate	....	.15	2.56	2.71	*2.4*	9.76	.69	.26	10.71	....	10.45	*10.0*	2.75	*1.5*	.30	35.00	29.22	19.7
2841	Bradley's Sea Fowl Guano	.20	.29	2.12	2.61	*2.5*	8.69	2.05	1.16	11.90	*11.0*	10.74	*9 0*	2.13	*2.0*	2.31	34.00	28.39	19.8
2882	Williams & Clark Co.'s Royal Bone Phosphate	....	...	1.66	1.66	*.8*	5.78	2.62	2.29	10.69	....	8.40	*7.0*	2.70	*2.0*	.36	29.00	23.30	20.4

Analyses of Nitrogenous Superphosphates Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.					
		Nitrogen as Nitrates.	Nitrogen as Ammonia	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.	Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
2852	Bradley's Anchor Brand Fish and Potash	....	....	3.76	3.76	*3.3*	4.76	1.84	1 36	7.96	*5.0*	6.60	*3.0*	2.67	*3.0*	4.64	$32.00	$26.39	21.3
2820	Bradley's Patent Superphosphate of Lime	.20	.14	2.37	2.71	*2.3*	8.53	2.42	1.10	12.05	....	10.95	*9.0*	1.98	*1.5*	2.00	35.00	28.84	21.4
2768	E. F. Coe's High Grade Phosphate	....	....	2.24	2.24	*2.0*	8.67	1.75	1.54	11.96	*11.0*	10.42	*9.0*	2.53	*2.0*	.33	34.00	27.95	21.6
2800	Chittenden's Complete Fertilizer	.81	....	3.03	3.84	*3.3*	3 34	5.60	3.79	12.73	*8.0*	8.94	*6.0*	5.49	*6.0*	1.84	42.00	34.52	21.7
2833	Reese's New England Favorite	....	....	2.51	2 51	*2.3*	6.86	3.31	2.84	13 01	*10 5*	10.17	*9.0*	1.81	*2.0*	2.05	34.00	27.83	22.1
2813	Clark's Cove Bay State Fertilizer, G.G.	....	.28	2.06	2.34	*1.9*	7.26	1.35	3.58	12 19	*10.5*	8.61	*8 5*	2.70	*2.3*	2.21	32 00	26.19	22.2
2889	Apothecaries Hall Co.'s Victor Phosphate	....	....	2.33	2.33	*2.5*	7.68	1.36	.04	9.08	*8.5*	9.04	....	2 24	*2 0*	1.97	30.00	24.30	22.6
2892	Read's Fish and Potash	....	....	2.78	2.78	*2.5*	3.52	2.46	1.73	7.71	*6.0*	5.98	*4.0*	4.96	*4 0*	5.05	30.00	24.28	23.5
2803	Bowker's Hill and Drill Phosphate	.81	....	2.05	2.86	*2.5*	7.52	2.21	2 64	12.37	*11.0*	9.73	*10.0*	2.40	*2.0*	.25	36 00	29.03	24.0
2905	Olds & Whipple's Special Phosphate	.87	....	2.07	2.94	....	8.61	1.07	.78	10.46	....	9.68	....	2.18	....	.42	35.00	27 88	25.5
2919	G. W. Miles' IXL Phosphate	....	.31	1.47	1.78	*2.0*	7.71	1.81	.74	10.26	....	9.52	*9.0*	2.26	*1.5*	1.86	30.00	23.60	27.1
2843	Original Coe's Superphosphate	.47	....	1.66	2.13	*2.1*	8.45	2.40	1.24	12.09	*10.0*	10.85	*8.0*	.99	*1.0*	1.13	33.00	25.77	28.1
2835	Soluble Pacific Guano	1.85	....	.70	2.55	*2.3*	8.10	2.68	1.36	12.14	*10.5*	10 78	*8.5*	1.97	*2.0*	1.92	35.00	27.33	28.1
2974	H. S. Miller's Dissolved Bone	....	.10	1.73	1.83	*1 6*	7.82	1.55	.65	10.02	*9.5*	9.37	*8 0*	2.94	*1.5*	.25	32.00	24.88	28.6
2907	Church & Co.'s Fish and Potash	....	.30	2.96	3.26	*3.3*	1.55	2.71	.88	5.14	*5.0*	4.26	....	3.89	*8.0*	6.90	28.00	21.67	29.2
2875	Quinnipiac Fish and Potash, Crossed Fishes Brand		.78	3.02	3.80	*3.3*	1.12	3.79	3.57	8.48	*5.0*	4.91	*3.0*	4.41	*3.0*	4.06	34.00	26.51	32.0

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
2807	Reese's Pilgrim Fertilizer	....	.28	1.42	1.70	*1.0*	5.70	1.00	2.22	8.92	*7.5*	6.70	*6.5*	2.99	*2.5*	2.57	$27.00	$20.42	32.2
2854	Clark's Cove King Philip Alkaline Guano	....	....	1.73	1.73	*1.2*	6.35	1.37	2.31	10.03	*7.5*	7.72	*6.5*	3.29	*3.0*	2.33	30.00	22.51	33.3
2829	Ludlam's Cecrops Fertilizer	.64	....	1.85	2.49	*3.3*	8.05	1.39	1.18	10.62	....	9.44	*7.0*	6.80	*7.0*	5.89	40.00	29.96	33.6
2830	Read's Farmers' Friend Fertilizer	....	....	1.95	1.95	*2.0*	7.37	2.92	1.62	11 91	*11.0*	10.29	*9.0*	2.25	*2.0*	2.23	34.50	25.80	33.7
2827	Ludlam's Cereal Fertilizer	.59	....	.87	1.46	*1.2*	8.64	1.26	2.11	12.01	*11.0*	9.90	*8.0*	2.34	*4.0*	4.01	32.00	23.78	34.6
2799	Crocker's Ammoniated Bone Superphosphate	....	....	2.97	2.97	*2.9*	6.77	2.09	1.60	10.46	....	8.86	*10.0*	1.49	*1.0*	1.25	36.00	26.37	36.5
2825	Read's Lion Brand Fertilizer	....	....	1.20	1.20	*.8*	6.64	2.74	1.33	10.71	*10.0*	9.38	*8.0*	4.19	*4.0*	4.80	32.00	23.39	36.7
2796	Crocker's New Rival Phosphate	....	....	1.48	1.48	*1.2*	6.51	2.76	2.59	11.86	....	9.27	*10.0*	2.14	*1.6*	2.13	32.00	23.07	38.7
2890	Mapes' Peruvian Guano	....	5.15	1 35	6.50	*6.7*	7.44	3.99	3.27	14.70	*14.7*	11.43	....	2.99	*3.0*	4.28	62.90	44.65	38.8
2855	E. F. Coe's Alkaline Bone Phosphate	....	....	1.42	1.42	*1.0*	6.96	2.70	3.47	13.13	*11.0*	9.66	*9.0*	2.07	*2.0*	.52	34.00	24.38	39.5
2851	Bradley's Triangle A, Fish and Potash	....	.62	2.00	2.62	*2.0*	3 25	1.60	1.35	6.20	*6.0*	4.85	*4.0*	3.99	*4.0*	6.12	30.00	20.91	43.5
2831	Farmers' Fertilizer Co.'s Fish and Potash	....	....	1.69	1.69	*1.6*	4.26	2.33	1.25	7.84	*7.0*	6.59	*6.5*	7.42	*13.0*	7.49	34.00	23.50	44.7
2856	E. F. Coe's High Grade Fish and Potash	....	....	2.21	2.21	*3.0*	.51	3.75	4.66	8.92	*6.0*	4.26	*4.0*	3.10	*2.0*	7.04	29.50	19.56	50.8
2895	Davidge's Vegetator	....	....	3.03	3.03	*2.9*	4.67	.82	.07	5.56	....	5.49	*5.0*	3.85	*4.0*	7.99	35.00	22.51	55.4
2894	Stearn's Ammoniated Bone Superphosphate	trace	.37	1.29	1.66	*1.6*	2.82	4.41	2.79	10.02	*8.5*	7.23	....	2.88	*2.5*	1.38	34.00	21.36	59.2
2832	Farmers' Fertilizer Co.'s Standard Special Formula.	.09	....	.65	.74	*.8*	7.30	2.09	.63	10.02	*10.0*	9.39	*8.0*	1.88	*4.0*	8.85	32.00	19.36	65.3
2872	Wilkinson's Economical Bone Fertilizer	....	....	1.02	1.02	*1.2*	.24	4.17	5.52	9.93	*6.0*	4.41	....	3.11	*3.0*	.44	32.00	17.00	88.2

Notes on Particular Analyses.

An analysis of READ'S HIGH GRADE FARMERS' FRIEND FERTILIZER was made on a mixture of two dealers' samples, one from W. Tillinghast, Plainfield, the other from W. F. Andross, East Hartford. This analysis is given below, No. **2877.** The manufacturers claim that this does not represent the average quality of the brand. As no other lots of this article were sampled by our agents, further analyses could not be made. Nitrogen, phosphoric acid and potash were, however, determined separately in each of the two samples from which the mixture had been made, Nos. **2936** and **2937,** and also in the sample deposited here at the beginning of the season by the manufacturer, No. **2938.** The results follow :

READ'S HIGH GRADE FARMER'S FRIEND FERTILIZER.

	2877	2936	2937	2938
Nitrogen	3.04	3.20	3.20	3.71
Nitrogen guaranteed	**3.3**	----	--	----
Soluble Phosphoric Acid	4.13	----	----	2.96
Reverted " "	2.07	----	----	3.13
Insoluble " "	1.36	----	----	2.62
Total Phosphoric Acid	7.56	7.60	7.25	8.71
Phosphoric Acid, guaranteed	**6.0**	----	----	----
Potash	9.64	9.49	9.52	7.87
Potash, guaranteed	**10.0**	----	----	----
Chlorine	9.15	----	----	----
Cost per ton	$38.50	----	----	----
Valuation	$29.56	----	----	30.70

The results show that the two samples were practically alike in composition, but contained half a per cent. less nitrogen and 1.7 per cent. more potash than the manufacturers' standard sample.

An analysis of E. F. COE'S "GOLD BRAND EXCELSIOR GUANO" was made on a mixture of two samples, one from stock of Arnold Rudd, New London, the other from D. N. Clark, Shelton. This analysis is given below, No. **2808.** The manufacturer states that this cannot possibly represent the Gold Brand ; that it has never run lower than 6 per cent. of potash and 2¾ per cent. of ammonia, while the phosphoric acid could not run over 9 per cent.

The great and unusual discrepancy between guarantee and actual composition creates a suspicion that the goods were not of this brand. Our sampling agent, however, distinctly remembers that the samples were drawn from bags bearing the Gold Brand mark. The determinations of nitrogen, phosphoric acid and potash in the separate samples are given below for comparison. We do not feel at liberty to suppress the analysis, while we accept the manufacturers' statement, that it does not represent the goods, and for that reason it has not been tabulated with other analyses of superphosphates.

E. F. COE'S GOLD BRAND EXCELSIOR GUANO.

	2808	2939	2940
Nitrogen, as Ammonia	.74	-- -	----
Organic Nitrogen	1 04	---	----
Total Nitrogen	1.78	1.53	2.11
Nitrogen, guaranteed	2.5	----	----
Soluble Phosphoric Acid	7.71	----	----
Reverted " "	2.14	----	----
Insoluble " "	1.79	----	----
Total Phosphoric Acid	11.64	12.56	11.12
Phosphoric Acid, guaranteed	8.0	----	----
Potash	4.27	3.47	4.74
Potash, guaranteed	6.0	----	----
Chlorine	.46	----	----
Valuation per ton	$27.63	----	----

Of "Bradley's Superphosphate," 29 samples were drawn by our agents, about half of them in the northern and half of them in the southern counties of the State. A mixture was prepared of equal parts of all of them, and on this mixture was made analysis No. **2820,** given on page 46, and reprinted below for comparison.

To test the accuracy of the work of sampling both by the agents and in the laboratory, a mixture was prepared of all samples drawn in the northern counties, No. **2885,** and another of all samples drawn in the southern counties, No. **2886,** and these were separately analyzed with the results below given, which show satisfactory agreement, and demonstrate the ability of the manufacturer to turn out a thoroughly uniform product, and the ability of the Station to put before consumers an accurate knowledge of the fertilizers they are using.

	2820	2885	2886
Nitrogen as nitrates	.20	.20	.20
Nitrogen as ammonia	.14	.16	.16
Organic Nitrogen	2.37	2.26	2.38
Total Nitrogen	2.71	2.62	2.74
Soluble Phosphoric Acid	8.53	8.54	8.35
Reverted " "	2.42	2.35	2.45
Insoluble " "	1.10	1.16	1.19
Total " "	12.05	12.05	11.99
Potash	1.98	1.74	1.89
Chlorine	2.00	1 98	1.66
Valuation	$28.84	28.28	28.68

Similarly agreeing results were also obtained in the case of another brand, which it is not necessary to present in detail.

2. Manufacturers' Samples.

The fertilizers named below, with the exception of Nos. **2913** and **2915,** were not found by the Station agents in any stock which they inspected, and accordingly the analyses were made on samples deposited at the Station by manufacturers.

2899. Bone and Potash, Circle Brand, made by Bradley Fertilizer Co., Boston, Mass.

2810. Dry Ground Fish, made by Joseph Church & Co., Tiverton, R. I.

2809. Fish and Potash, made by Joseph Church & Co., Tiverton, R. I.

2916. Red Brand Excelsior Guano, made by E. Frank Coe, New York.

2900. Buffalo Superphosphate, No. 2, made by Crocker Fertilizer Co., Buffalo, N. Y.

2902. Queen City Phosphate, made by Crocker Fertilizer Co., Buffalo, N. Y.

2903. Vegetable Bone Superphosphate, made by Crocker Fertilizer Co., Buffalo, N. Y.

2911. Extra Bone Phosphate, made by L. B. Darling, Pawtucket, R. I.

2966. Davidge's Special Favorite, made by Davidge Fertilizer Co., New York.

2913. Clark's Cove Co.'s Great Planet A, made by J. S. Reese & Co., licensees, New Bedford, Mass.

2915. Pacific Fish and Potash, made by W. D. Stewart & Co., Boston, Mass.

2679. Wilcox's Dry Ground Fish Guano, and **2680,** Wilcox's Acidulated Fish Guano, both made by Leander Wilcox, Mystic Bridge.

Manufacturer's Samples—Analyses and Valuations.

	2899	2810	2809	2916	2900	2902	2903	2911	2966	2913	2915	2679	2680
Nitrogen as nitrates	----	----	----	.23	----	----	----	.41	----	.99	----	----	----
Nitrogen as ammonia	.20	----	.36	1.44	----	----	----	.25	.45	----	----	.21	1.19
Nitrogen, organic	1.51	7.10	3.22	2.30	----	1.71	4.07	3.10	1.03	2.42	3.33	8.16	4.84
Total Nitrogen found	1.71	7.10	3.58	3.97	----	1.71	4.07	3.76	1.48	3.41	3.33	8.37	6.03
Nitrogen guaranteed	**1.8**	**8.2**	**3.3**	**3.3**	----	**1.7**	**5.0**	----	**1.2**	**3.3**	**3.0**	----	----
Soluble phosphoric acid	trace	----	1.63	7.61	11.47	7.31	6.38	4.75	8.32	4.08	4.14	.89	1.28
Reverted phosphoric acid	8.23	----	2.74	.87	2.04	2.17	1.59	4.22	2.99	4.88	2.02	3.73	3.00
Insoluble phosphoric acid	5.73	----	.72	1.15	.92	1.82	.55	2.19	1.75	2.81	.74	2.35	.95
Total phosphoric acid found	13.96	8.05	5.09	9.63	14.43	11.30	8.52	11.16	13.06	11.77	6.90	6.97	5.23
Phosphoric acid guaranteed	**8.0**	----	**5.0**	----	**12.0**	**9.0**	**7.0**	----	----	**8.3**	**6.0**	----	----
Available phosphoric acid found	8.23	----	4.37	8.48	13.51	9.48	7.97	8.97	11.31	8.96	6.16	4.62	4.28
Available phosphoric acid guaranteed	----	----	----	**10.0**	**11.0**	**8.0**	**6.0**	----	**10.0**	**7.3**	**4.0**	----	----
Potash	4.45	----	4.19	4.00	1.91	2.16	7.42	3.68	2.11	9.50	2.53	----	----
Potash guaranteed	**2.0**	----	**3.0**	**4.8**	**1.0**	**1.0**	**6.0**	----	**1.5**	**9.5**	**4.0**	----	----
Chlorine	10.76	----	7.27	.12	1.96	2.16	6.70	1.12	2.17	9.22	3.39	----	----
Valuation per ton	$25.61	----	29.03	32.32	23.68	23.81	33.45	31.80	25.78	35.19	23.70	36.88	27.63

3. *Samples drawn by Private Individuals.*

2859. Sanderson's Formula A. Made by L. Sanderson, New Haven. Sampled from stock bought by J. H. Webb, Hamden. See also analysis No. **2748,** page 44.

ANALYSIS.	2859
Nitrogen as nitrates	.47
Nitrogen as ammonia	1.27
Organic nitrogen	2.89
Soluble phosphoric acid	4.11
Reverted phosphoric acid	2.88
Insoluble phosphoric acid	1.71
Potash	7.96
Chlorine	3.32
Cost per ton	$35.00
Valuation per ton	35.67

II. SPECIAL MANURES.

1. *Sampled by Station Agents.*

For Analyses and Valuations see pages 55–61.

Here are included such Nitrogenous Superphosphates as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

Guarantees.—Of the thirty-three samples analyzed ten are below the maker's minimum guarantee as regards one ingredient and two are below guarantee on two ingredients.

COST AND VALUATION.—In one case the valuation exceeded the cost.

The average cost of 33 special manures has been $39.18 and the average valuation $32.90. The difference between cost and valuation has been $6.28 and the Percentage Difference 19.0. The corresponding difference in case of the superphosphates (see page 35) was 18.3 per cent.

This year the Special Manures as a class have been higher-priced and more concentrated than the other nitrogenous superphosphates, but not as heretofore more economical to purchase.

Manufacturers' Samples of Special Manures.

The fertilizers named below were not found by the Station agents in any stock which they inspected, and accordingly the analyses were made on samples deposited at the Station by manufacturers.

2898. Complete manure for Grass and Grain, made by Bradley Fertilizer Co., Boston, Mass. Sent in April.

2961. Bradley's Complete Manure for Grass and Grain. Sent n July.

2901. Special Potato Manure, made by Crocker Fertilizer Co., Buffalo, N. Y.

2912. Great Eastern General Fertilizer for Oats, Buckwheat, and Seeding Down. Made by Great Eastern Fertilizer Co., Rutland, Vt.

2914. Concentrated Manure for Tobacco and Cabbage, made by J. S. Reese & Co., New Bedford, Mass.

The analysis of **2898**, it was claimed by the manfacturer, did not represent the average quality of the goods, though sent to us from the factory. A second sample was accordingly sent from the factory in July and was also analyzed, (No. **2961.**)

ANALYSES AND VALUATIONS.

	2898	2961	2901	2912	2914
Nitrogen as Nitrates	4.54	4.84	1.44	....	.41
Nitrogen as Ammonia	....	....	....	....	.27
Organic Nitrogen	.08	.09	2.35	1.02	3.28
Total Nitrogen found	4.62	4.93	3.79	1.02	3.96
Nitrogen, guaranteed	*4.94*	*4.9*	*3.7*	*.8*	*4.1*
Soluble Phosphoric Acid	3.28	6.19	6.69	6.83	4.69
Reverted Phosphoric Acid	2.30	1.97	1.84	1.80	2.03
Insoluble Phosphoric Acid	.94	1.01	1.77	1.03	2.43
Total Phosphoric Acid found	6.52	9.17	10.30	9.66	9.15
Phosphoric Acid, guaranteed	*7.0*	*7.0*	*9.0*	*9.0*	*6.0*
Available Phosphoric Acid found	5.58	8.16	8.53	8.63	6.72
Available Phosphoric Acid, guaranteed	....	....	*8.0*	*8.0*	*5.0*
Potash	2.63	3.39	6.74	3.85	5.97
Potash, guaranteed	*2.5*	*2.5*	*5.5*	*4.0*	*5.0*
Chlorine	.45	.40	6.32	4.69	4.82
Valuation per ton	$25.69	$31.73	$32.77	$21.19	$30.65

Notes on Particular Analyses.

Analyses Nos. **2837** and **2838** given below are objected to by the manufacturer as not representing the average composition of the goods, Stockbridge Top Dressing. No other samples of this brand were found by our agents, and no other analyses could be made. On account of the manufacturer's protest, these analyses

are not tabulated with the others. It sometimes happens that goods are re-bagged by the dealer when the original bags are torn or rotted, and in such cases there is chance that the new bags may bear the wrong brand. Wrong tags may also occasionally be attached to unstenciled bags at the factory.

STOCKBRIDGE TOP DRESSING.

	2827	2828
Nitrogen as nitrates	1.75	1.96
Organic Nitrogen	2.83	2.41
Total Nitrogen	4 58	4.37
Soluble Phosphoric Acid	3.10	1.09
Reverted "	1.38	3.49
Insoluble "	5.96	6.59
Total Phosphoric Acid	10.44	11.17
Potash	4.46	5.24
Chlorine	4.49	4.79
Valuation per ton	$29.33	29.56

In the table below, **2794**, is an analysis made on a mixture of four samples of H. S. Miller & Co.'s Special Potato Manure. The manufacturer stated that the per cent. of phosphoric acid found was less than the brand should contain. Phosphoric acid was accordingly determined in each of the four samples, and the following per cents. were found: 5.41, 7.91, 7.82, 7.84. Evidently the first sample was unlike all the rest. It was, therefore, rejected, and a mixture of the other three gave the analysis, No. 2950, as follows:

H. S. MILLER & CO.'S SPECIAL POTATO MANURE.

	2794	2950
Nitrogen as nitrates	.52	- -
Nitrogen as ammonia	2.31	3.07
Organic Nitrogen	1.10	.78
Soluble Phosphoric Acid	4.53	3.89
Reverted "	1.95	3.08
Insoluble "	.47	.92
Potash	7.76	7.88
Chlorine	.42	.37
Valuation per ton	$32.70	33.79

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2684	Fairchild's Formula for Seeding Down.	Rogers & Hubbard Co., Middletown.	Manufacturers.	$40.00
2710	Soluble Potato Manure.	Rogers & Hubbard Co., Middletown.	Manufacturers.	37.00
2685	Fairchild's Formula for Corn and General Crops.	Rogers & Hubbard Co., Middletown.	Manufacturers.	46.00
2951	Mapes' Seeding Down Manure.	Mapes' F. & P. G. Co., New York.	Mapes' Branch, Hartford.	37.50
2871	Fruit and Vine Manure.	Mapes' Formula and Peruvian Guano Co., New York.	Mapes' Branch, Hartford.	38.00
2819	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	D. N. Clark & Sons, Milford.	39.00
			Geo. Dickinson, Haddam.	40.00
			Wilson & Burr, Middletown.	38.00
			J. E. Holmes, Stratford.	38.00
			Carter & Strong, Manchester.	42.00
			F. S. Bidwell, Windsor Locks.	38.00
2801	Corn Manure.	Mapes' Formula and Peruvian Guano Co., New York.	Mapes' Branch, Hartford.	41.00
			W. W. Cooper, Suffield.	41.00
			G. K. Nason. Willimantic.	42.60
			J. P. Barstow & Co., Norwich.	41.00
			Dean & Horton, Stamford.	42.00
2858	Tobacco Manure, Connecticut Brand.	Mapes' Formula and Peruvian Guano Co., New York.	Mapes' Branch, Hartford.	45.00
			W. W. Cooper, Suffield.	45.00
2893	Americus High Grade Special for Tobacco.	Williams & Clark Fertilizer Co., 81 Fulton St., New York.	Hale, Day & Co., South Manchester.	40.00
			John Bransfield, Portland.	40.00
2824	Grass and Grain Spring Top Dressing.	Mapes' Formula and Peruvian Guano Co., New York.	G. K. Nason, Willimantic.	42.60
			W. W. Cooper, Suffield.	41.00
			Mapes' Branch, Hartford.	41.00
2804	Complete Potato Manure.	H. J. Baker & Bro., 215 Pearl St., N. Y.	M. T. Gregory & Co., Milford.	42.00
			Allen Betts, Norwalk.	42.00
			W. W. Cooper, Suffield.	42.50
			E. F. Hawley. Newtown.	42.50
2975	Corn Fertilizer.	H. S. Miller & Co., Newark, N. J.	G. T. Fowler, Branford.	32.00

Special Manures Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2952	Stockbridge Seeding Down Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Southington Lumber & Feed Co., Southington.	$40.00
2836	Complete Corn Manure.	H. J. Baker & Bro., 215 Pearl St., N. Y.	Strong & Tanner, Winsted.	40.00
			S. J. Hall, Meriden.	42.00
			W. W. Cooper, Suffield.	42.50
			I. J. Scoville, Bristol.	40.00
2950	Special Potato Manure.	H. S. Miller & Co., Newark, N. J.	Staples & Raymond, Westport.	42.00
			H. P. Treat, Orange.	40.00
2759	Potato Manure.	Mapes' Formula and Peruvian Guano Co., N. Y.	G. K. Nason, Willimantic.	44.50
			Mapes' Branch, Hartford.	43.00
			J. P. Barstow & Co., Norwich.	44.00
			Wilson & Burr, Middletown.	43.00
			Wheeler & Howe, Bridgeport.	45.00
2861	Tobacco Manure, Wrapper Brand.	Mapes' Formula and Peruvian Guano Co., N. Y.	W. W. Cooper, Suffield.	52.00
			Mapes' Branch, Hartford.	50.00
2818	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	J. A. Lewis, Willimantic.	35.00
			Dix & Wells, Wethersfield.	33.00
			C. A. Young, Danielsonville.	33.00
2840	Bowker's Tobacco Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	W. B. Martin, Rockville.	44.00
2767	Potato Manure.	Williams & Clark Fertilizer Co., 81 Fulton St., N. Y.	Charles Stagg, Stratford.	35.00
			Joseph Roode, Jewett City.	36.00
			Daniel Morgan, Poquonock.	35.00
			H. K. Brainard, Thompsonville.	36.00
			C. L. Backus, Andover.	----
			F. S. Bidwell, Windsor Locks.	36.00
			Abbott & Co., Birmingham.	40.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2821	Potato Manure.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	A. C. Sternberg, Hartford.	$37.00
			F. S. Bidwell, Windsor Locks.	35.00
			D. N. Clark & Sons, Milford.	35.00
			Wilson & Burr, Middletown.	35.00
			N. C. Barker, Lebanon.	37.00
			D. Beers, Danbury.	38.00
			City Coal and Wood Co., New Britain.	40.00
			W. H. Cheney's Sons, South Manchester.	39.00
			Waterbury & June, Greenwich.	----
			Raymond Bros., South Manchester.	37.00
			W. B. Martin, Rockville.	37.00
			G. R. Fowler, Central Village.	----
			G. W. Carver, Putnam.	36.00
			Carter & Strong, Manchester.	39.00
			J. E. Leonard, Jewett City.	38.00
			G. A. Dickinson, Haddam.	38.00
			F. C. Root, Suffield.	38.00
			W. F. Andross, East Hartford.	36.00
			W. W. Cooper, Suffield.	36.00
			J. S. Wells, Hebron.	36.00
			E. B. Clark, Woodmont.	37.00
2763	Stockbridge Vegetable Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	E. B. Clark, Milford.	38.00
			L. Browning, New London.	42.50
			E. B. Clark, Woodmont.	40.00
			J. A. Lewis, Willimantic.	40.00

Special Manures Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2842	Complete Manure for Corn and Grain.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	J. E. Holmes, Stratford.	$42.00
			D. N. Clark & Sons, Milford.	39.00
			Carter & Strong, Manchester.	42.00
2764	Potato Manure.	Quinnipiac Co., New London.	B. E. Johnson, Higganum.	34.00
			John Taylor, Old Mystic.	38.00
			J. S. Worthington, Portland.	40.00
			J. F. Silliman, New Canaan.	38.00
			D. C. Wood, Stratford.	38.00
			G. M. Williams, New London.	35.00
			Olds & Whipple, Hartford.	40.00
2816	Potato Manure.	E. Frank Coe, 16 Burling Slip, N. Y.	J. A. Amidon, Wethersfield.	40.00
			N. C. Barker, Lebanon.	36.00
			H. S. Hall, (2d) Wallingford.	40.00
2826	Great Eastern Vegetable, Vine and Tobacco Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	D. E. Stone, Cheshire.	33.00
			L. L. Herman, Noroton.	35.00
			F. Woodford, Farmington.	37.00
			Andrew Bonfoey, Higganum.	35.00
			W. A. Snow, Columbia.	35.00
2834	Reese's Concentrated Potato and Corn Manure.	J. S. Reese & Co., New Bedford, Mass.	W. Tillinghast, Plainfield.	39.00
2897	Stockbridge Fruit Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. A. Paine, Danielsonville.	42.50
			J. A. Lewis, Willimantic.	40.00
2814	Stockbridge Corn Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	E. S. Lincoln, Chaplin.	38.00
			S. R. Jones, Deep River.	40.00
			J. A. Lewis, Willimantic.	40.00
			City Coal and Wood Co., New Britain.	41.00
			W. B. Martin, Rockville.	41.00

SPECIAL MANURES SAMPLED BY THE STATION—*Concluded.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
2814	Stockbridge Corn Manure.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. A. Paine, Danielsonville.	$42.50
			J. M. Williams, Manchester.	39.00
			W. H. Anderson, Putnam.	42.00
2817	Potato, Hop and Tobacco Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	Dix & Wells, Wetherstield.	35.00
			C. A. Young, Danielsonville.	36.00
			W. Tillinghast, Plainfield.	36.00
			L. L. Herman, Noroton.	35.00
			J. E. Leonard, Jewett City.	36.00
			L. Browning, New London.	37.00
			J. H. Fish, Newington.	38.00
			W. C. Russell, Orange.	35.00
			E. Hill, Moosup.	36.00
2853	General Fertilizer for Grain and Grass.	Great Eastern Fertilizer Co., Rutland, Vt.	W. A. Snow, Columbia.	35.00
2878	Potato Manure.	Davidge Fertilizer Co., 121 Front St., N. Y.	Henry Dackett, Andover.	40.00
2881	Stearns' Potato Grower.	Stearns Fertilizer Co., 181 Front St., N. Y.	R. P. Hubbard, Middletown.	34.00

Analyses of Special Manures Sampled by the Station.

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
2684	Fairchild's Formula for Seeding Down†	.25	....	2.81	3.06	*2.5*	....	....	....	16.61†	*18.0*	....	....	14.67	*12.5*	13.92	$40.00	$44.73	11.0*
2710	Rogers & Hubbard's Soluble Potato Manure	1.36	.72	3.24	5.32	*5.0*	1.08	6.20	3.61	10.89	*10.0*	7.28	....	5.33	*5.0*	.22	37.00	36.91	0.2
2685	Fairchild's Formula for Corn and General Crops‡	3.40	....	1.92	5.32	*5.5*	....	....	....	13.30‡	*12.0*	....	....	12.53	*13.0*	12.06	45.00	44.67	0.7
2951	Mapes'Seeding Down Manure	.83	.15	2.41	3.39	*2.5*	....	....	....	15.24§	*15.0*	....	....	11.71	*10.0*	11.56	37.50	34.29	9.3
2871	Mapes'Fruit and Vine Manure	.23	.35	1.42	2.00	*1.7*	8.77	.49	.14	9.40	....	9.26	*7.0*	11.16	*10.0*	.52	38.00	34.74	9.4
2819	Bradley's Comp. Manure for Potatoes and Vegetables	.38	1.39	1.99	3.76	*3.7*	7.06	2.64	.96	10.66	*9.0*	9.70	*8.0*	6.49	*6.0*	6.60	38.00	34.28	10 9
2801	Mapes' Corn Manure	.75	1.06	2.03	3.84	*3.7*	6.30	3.83	1.97	12.10	....	10.13	*10.0*	6.76	*6.0*	6.41	41.00	35.79	14.6
2858	Mapes' Tobacco Manure, Conn. Brand	.83	1.52	2.23	4.58	*4.7*	6.08	2.50	1.04	9.62	....	8.58	*7.8*	8.46	*7.8*	.59	45.00	39.19	14.8
2893	Williams & Clark's Americus High Grade Special for Tobacco	.72	1.17	1.60	3.49	*3.7*	4.32	4.85	1.88	11.05	*8.0*	9.17	*7.0*	6.70	*7.0*	.20	40.00	34.80	14.9
2824	Mapes' Grass and Grain Spring Top Dressing	1.54	1.44	1.89	4.87	*4.1*	5.74	2.80	1.69	10.23	*7.0*	8.54	*7.0*	5.93	*5.0*	5.51	41.00	35.55	15.8
2804	Baker's Comp. Potato Manure	....	3.43	.77	4.20	*3.3*	5.98	1.40	.30	7.68	....	7.38	*5.0*	9.98	*10.0*	5.02	42.00	36.11	16.3
2952	Stockbridge Seeding Down Manure	1.56	.15	1.93	3.64	*2.5*	7.36	2.25	2.25	11.86	*12.0*	9.61	*6.0*	4.88	*3.0*	.34	40.00	33.83	18.2
2975	Miller's Corn Fertilizer	...	....	2.04	2.04	*1.4*	5.15	4 06	1.06	10.27	*7.5*	9.21	*6.5*	4.14	*3.0*	.34	32.00	26·74	19.6
2836	Baker's Comp. Corn Manure	....	3.49	.73	4 22	*4.9*	5.97	1.26	.18	7.41	....	7.23	*6.3*	9.17	*7.0*	7.02	41.00	34.15	20.1
2950	Miller's Special Potato Manure	....	3.07	.78	3.85	*3.7*	3.89	3.08	.92	7.89	....	6.97	*8.5*	7.88	*7.0*	.37	41.00	33.79	21.3
2759	Mapes' Potato Manure	1.46	.85	1.60	3.91	*3.7*	3.90	4.32	2.54	10.76	*8.0*	8.22	*8.0*	7.32	*6.0*	.57	43.00	35.36	21.6

* Valuation exceeds cost. † Mixture of chemicals and ground bone, 93 per cent. of which passes holes $\frac{1}{10}$ inch in diameter. ‡ Mixture of

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.					
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.	Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
2861	Mapes' Tobacco Manure, Wrapper Brand	1.17	3.53	1.42	6.12	*6.2*	1.18	3.05	1.82	6.05	....	4.23	*4.5*	11.43	*10.5*	1.06	$50.00	$41.08	$21.7
2818	Crocker's Ammoniated Wheat and Corn Phosphate	....	.16	2.22	2.38	*2.0*	7.81	2.14	2.08	12 03	..	9.95	*10.0*	1.95	*1.8*	1.92	33.00	26.81	23.1
2840	Bowker's Tobacco Manure	....	1.60	1.87	3.47	*3.3*	7.13	2.13	3.16	12.42	*8.0*	9.26	*7.0*	5.08	*5.0*	.48	42.50	34.22	24.2
2767	Williams & Clark's Potato Manure	.29	....	2.55	2.84	*2.0*	5 41	2.96	1.12	9.49	....	8.37	*8.0*	5.75	*6.0*	3.09	36.00	28.96	24.3
2821	Bradley's Potato Manure	.29	...	2.34	2.63	*2.5*	6.43	2.43	1.50	10.36	*8.0*	8.86	*6 0*	5.87	*5.0*	5.79	36.00	28.91	24.5
2763	Stockbridge Vegetable Manure	1.32	.47	1.62	3.41	*3.3*	6.88	1.83	1.47	10.18	*8.0*	8.71	*7.0*	6.73	*5.0*	4.20	40.00	31.98	25.1
2842	Bradley's Complete Manure for Corn and Grain	.31	1.00	1.98	3.29	*3.3*	7.47	2.38	1.31	11.16	*10.0*	9.85	*8.0*	5.02	*4.5*	5.27	40.00	31.86	25.5
2764	Quinnipiac Potato Manure	.35	....	2.75	3.10	*2.5*	4.00	3.82	1.24	9.06	*5.0*	7.82	*5.0*	5.40	*5.0*	.96	37.00	29.35	26.0
2816	E. Frank Coe's Potato Manure	....	.66	1.64	2.30	*2.0*	7.49	1.69	1.40	10.58	*8.0*	9.18	*8.0*	5.69	*6.0*	.34	38.00	29.89	27.1
2826	Great Eastern Vegetable, Vine and Tobacco Fertilizer	....	....	2.14	2.14	*2.1*	7.04	1.92	1.20	10.16	....	8.96	*8.0*	5.97	*6.0*	5.69	35.00	27.52	27.2
2834	Reese's Concentrated Potato and Corn Manure	.37	....	2.62	2.99	*2.7*	3.36	4.73	3.14	11.23	*7.0*	8.09	*6.0*	6.95	*7.5*	7.06	39.00	30.61	27.4
2897	Stockbridge Fruit Manure	.64	....	1.79	2.43	*2.5*	7.31	2.46	2.77	12.54	*7.0*	9.77	*6.0*	5.38	*4.0*	.62	40.00	31.21	28.2
2814	Stockbridge Corn and Grain Manure	.81	....	2.46	3.27	*3.2*	6.50	2.66	3.07	12.23	*10.0*	9.16	*8.0*	4 17	*4.0*	3.06	40.00	30.73	30.2
2817	Crocker's Potato, Hop and Tobacco Phosphate	....	....	2.07	2.07	*2.0*	8.40	1.73	1.29	11.42	*8.0*	10.13	*8.0*	4.19	*3.5*	3.70	36.00	27.63	30.3
2853	Great Eastern General Fertilizer for Grass and Grain.	....	....	2.80	2.80	*2.9*	7.06	1.69	1.27	10.02	....	8.75	*8.0*	2.43	*2.0*	2.86	35.00	26.31	33.0
2878	Davidge Potato Manure	1.11	....	1.81	2.92	*2.9*	6.75	3.16	1.28	11.19	....	9.91	*9.0*	4.23	*4.0*	4.48	40.00	29.50	35.6
2881	Stearns' Potato Grower	....	.65	1.36	2.01	*2.5*	4.14	2.06	2.46	8.66	*5.0*	6 20	...	5.34	*5.0*	.62	34.00	24.20	40.5

Home-Mixed Fertilizers.

Following are analyses of all the samples of Home-Mixed Fertilizers which have been sent to the Station this year, with such facts as could be obtained regarding their cost, etc. The formulas by which the fertilizers were mixed are first given, followed by the table of analyses and valuations, with some explanations and further remarks.

2703. Phosphate made by Lawrence Doyle, Harwinton. This was mixed last year, but the formula by which it was prepared was mislaid and cannot be given.

2742. Mixture for corn, made by Dennis Fenn, Milford.

Formula.

500	pounds	Ground Bone,	costing	$8.25
200	"	Muriate of Potash,	"	4.25
100	"	Sulphate of Potash,	"	1.50
500	"	Dissolved Bone Black,	"	6.50
350	"	Tankage,	"	6.13
500	"	Nitrate of Soda,	"	12.50
2150				$39.13

Cost of Materials, $36.40 per ton.

2744. Mixture for Potatoes. Made by Dennis Fenn, Milford.

Formula.

200	pounds	Muriate of Potash,	costing	$ 4.26
300	"	Sulphate of Potash,	"	4.50
750	"	Tankage,	"	13.12
350	"	Nitrate of Soda,	"	8.75
500	"	Dissolved Bone Black,	"	6.50
2100				$37.13

Cost of Materials, $35.36 per ton delivered at Milford.

2745. Mixture for Corn, etc. Made by W. L. & S. T. Merwin, Milford.

Formula.

1668	pounds	Dissolved Bone Black,	costing	$21.68
1334	"	Tankage,	"	23.34
334	"	Muriate of Potash,	"	7.09
668	"	Sulphate of Potash,	"	10.02
333	"	Sulphate of Ammonia,	"	12.48
500	"	Fine Ground Bone,	"	8.25
4837				$82.86

Cost of materials $34.26 per ton delivered at Milford.

2746. Mixture for Potatoes, etc. Made by W. L. & S. T. Merwin, Milford.

FORMULA.

1668	pounds	Dissolved Bone Black,	costing	$21.68
1534	"	Tankage,	"	26.84
334	"	Muriate of Potash,	"	7.09
668	"	Sulphate of Potash,	"	10.02
333	"	Sulphate of Ammonia,	"	12.48
4537				$78.11

Cost of materials $34.43 per ton delivered at Milford.

2737. Mixture for Turnips and Grass. Made by W. L. & S. T. Merwin, Milford.

FORMULA.

800	pounds	Dissolved Bone Black,	costing	$10.40
400	"	Tankage,	"	7.00
600	"	Sulphate of Potash,	"	9.00
150	"	Sulphate of Ammonia,	"	5.62
300	"	Nitrate of Soda,	"	7.50
250	"	Fine Ground Bone,	"	4.12
2500				$43.64

Cost of materials $34.92 per ton delivered at Milford.

2743. Mixture for Potatoes. Made by G. F. Platt, Milford.

FORMULA.

800	pounds	Blood, Bone and Meat,	costing	$14.00
400	"	Bone,	"	6.60
550	"	Dissolved Bone Black,	"	7.15
50	"	Sulphate of Ammonia,	"	1.87
50	"	Nitrate of Soda,	"	1.25
100	"	Sulphate of Potash,	"	1.50
50	"	Muriate of Potash,	"	1.06
2000				$33.43

Cost of materials $33.43 per ton delivered at Milford.

2738. Mixture made by N. D. Platt, Milford.

FORMULA.

1333	pounds	Tankage,	costing	$23.32
1333	"	Bone Black,	"	17.33
333	"	Ground Bone,	"	5.50
333	"	Sulphate of Ammonia,	"	12.50
333	"	Muriate of Potash,	"	7.08
333	"	Sulphate of Potash,	"	5.00
3998				$70.73

Cost of materials $35.36 per ton delivered at Milford.

2747. Mixture for General Use. Made by R. M. Treat, Woodmont.

FORMULA.

450	pounds	Tankage,	costing	$ 7.88
170	"	Sulphate of Ammonia,	"	6.38
1000	"	Dissolved Bone Black,	"	13.00
280	"	Muriate of Potash,	"	5.95
100	"	Bone,	"	1.65
2000				$34.86

Cost of materials $34.86 per ton delivered at Milford.

Nos. **2703** and **2737** were sampled by private individuals, all the others by a Station agent.

The raw materials from which these mixtures were prepared were analyzed, and knowing their composition and the quantity of each which was used, the composition of the mixtures can be calculated, assuming that all weights were correctly taken, that the materials had not lost or gained moisture and that both mixing and sampling had been thorough. These calculated analyses are given in the table to compare with the actual composition of the mixtures. The agreement of the calculated with the actual composition is not as close as it would have been had the mixing been thorough and the weights correct. In all cases the valuation is lower than if the formula had been exactly followed.

The mechanical condition of these mixtures is good and their chemical composition corresponds with that of the high grade "special fertilizers" and ammoniated superphosphates.

The cost above given is in every case based on the regular cash ton prices of the trade. The *actual* cost in many, if not all, of these cases has been very considerably reduced by special rates

which are given where a number of farmers give a cash order for a car lot or more.

The average cost of materials in these home mixed fertilizers has been $34.23 per ton delivered at the purchaser's freight station. Two dollars will fully cover the cost of screening and mixing. [From a dollar to a dollar and a half is the estimate of those who have done the work.] *At the highest estimate*, therefore, the average cost of these home-mixed fertilizers has been $36.23 per ton. The average valuation has been $34.85 per ton. On the basis of these figures the average difference between cost and valuation has been less than 6 per cent. In factory-mixed goods it has averaged in round numbers 18 per cent.

The attention of those who plan to try home-mixing is called to the following particulars:

1. Nitrogen has come highest this season in ammonia salts, about 18 cents per pound; in nitrates it has cost from 15 1-2 to 16 1-2 cents per pound. Nitrogen in Castor Pomace has cost about the same. Cotton seed meal remains the cheapest source of quickly available nitrogen which it has furnished at 12 to 14 cents per pound. In one case adulterated Cotton seed meal has been found in the Conn. market. See page 25.

2. At present the superphosphate used in home-mixtures is dissolved bone-black, but soluble phosphoric acid can be bought considerably cheaper in dissolved South Carolina rock.

Besides superphosphates there are other sources of phosphoric acid which should be considered. On some soils, Thomas-Slag has given as good results as superphosphates, and there are other native phosphates in which the ratio between cost and agricultural value may be for some soils and crops as favorable as in superphosphates. Fine ground bone coo, which contains from 24–30 per cent. of phosphoric acid and from 3.5–4.0 per cent. of nitrogen can be got for from $26–32 per ton; while bone-black superphosphate, containing 17 per cent. of phosphoric acid and a small fraction of 1 per cent. of nitrogen costs $26. Attention is also called to the precipitated phosphate mentioned on page 27. Its mechanical condition is excellent and it supplies readily available phosphoric acid at a low price.

3. Potash in sulphates costs about 6 cents per pound, in muriate from 4 to 4 1-2 cents. Kainit contains large quantities of chlorine and should be regarded as an impure muriate rather than as a sulphate. Potash in kainit costs at retail more than in muriate, about 4.8 cents per pound. As may be seen on page 68, potash as a carbonate and perhaps phosphate, has averaged 5.4 cents per pound in cotton-hull ashes. At the lower figure they are an excellent source of potash. The only objection to their use is the great variation in quality. As a result of this the buyer can have no certainty regarding them without a chemical analysis.

Home Mixed Fertilizers.--Analyses and Valuations.

Station No.	Name.	Nitrogen.					Phosphoric Acid.					Potash.		Chlorine.	Valuation per Ton.	Cost per Ton.
		As Nitrates.	As Ammonia.	Organic.	Total. Found.	Total. Calculated	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Calculated.	Found.	Calculated			
2703	Lawrence Doyle, Home Mixture	....	....	3.27	3.27	....	5.15	1.53	.24	6.92	....	7.92	...	....	$31.30	$32.00
2742	Dennis Fenn, Mixture for Corn	3.44	....	1.79	5.23	*5.4*	5.57	4.88	1.38	11.83	*13.0*	4.00	*5.9*	2.17	37.06	36.40
2744	Dennis Fenn, Mixture for Potatoes	2.49	....	1.87	4.36	*4.5*	4.32	3.32	.70	8.34	*11.1*	6.71	*8.7*	2.77	32.84	35.36
2745	W. L. & C. T. Merwin, Mixture for Corn	....	1.51	2.47	3.98	*4.0*	6.05	3.00	.81	9.86	*10.9*	7.42	*7.0*	3.89	35.55	34.26
2746	W. L. & C. T. Merwin, Mixture for Potatoes	....	1.35	1.75	3.10	*4.3*	6.35	3.73	1.50	11.58	*9.3*	6.75	*7.5*	3.61	33.86	34.43
2737	W. L. & C. T. Merwin, Mixture for Turnips and Grass	1.78	1.29	1.49	4.56	*4.8*	6.38	2.11	1.83	10.32	*9.4*	5.64	*6.2*	....	35.63	34.92
2743	G. F. Platt, Mixture for Potatoes	.37	.58	3.56	4.51	*4.9*	4.97	6.07	3.03	14.07	*13.3*	2.30	*2.5*	1.33	36.25	33.43
2738	N. D. Platt, Home Mixture	....	1.75	2.79	4.54	*3.7*	5.37	3.36	2.46	11.19	*14.3*	5.54	*6.4*	3.34	35.87	35.36
2747	R. M. Treat, Mixture for General Use	....	1.80	1.66	3.46	*3.1*	9.25	1.55	.36	11.16	*14.2*	8.19	*7.2*	6.87	35.28	34.86

ANALYSES OF COTTON HULL ASHES.

Station No.	Dealer or Purchaser.	Sampled by	Soluble Phosphoric Acid.	"Reverted" Phosphoric Acid.	Insoluble Phosphoric Acid.	Potash soluble in water.	Cost per Ton.	Valuation per Ton.	Potash costs per pound in cents.
2642	R. E. Pinney, Suffield	C. H. Wells, Suffield	.46	6.84	.99	19.36	$33.00	$34.62	*5.6*
2652	C. L. Spencer, Suffield	F. C. Root, Suffield	.40	6.68	1.24	22.79	35.00	38.51	*5.2*
2657	R. A. Parker, Warehouse Point	John Mason, Warehouse Point	.64	5.14	1.17	20.00	35.00	33.20	*6.4*
2660	R. A. Parker, Warehouse Point	A. Z. Fowler, Warehouse Point	2.08	7.58	1.09	22.81	35.00	42.50	*4.4*
2661	F. W. Mack, Windsor	H. S. Frye, Poquonock	2.94	7.74	1.95	25.69	30.00	47.91	*2.5*
2671	C. L. Spencer, Suffield	W. H. Prout, Suffield	.54	8.07	1.33	19.07	35.00	36.37	*5.6*
2713	R. A. Parker, Warehouse Point	E. F. Thompson, Warehouse Point	1.23	6.28	2.40	25.28	35.00	42.68	*4.5*
2718	Allen Wilson, Suffield	Arthur Sikes, Suffield	1.10	4.80	4.81	21.10	34.00	36.20	*5.5*
2717	C. L. Spencer, Suffield	Allen Wilson, Suffield	.70	5.09	2.77	17.81	35.00	31.23	*7.0*
2731	Olds & Whipple, Hartford	Olin Wheeler, Buckland	1.62	7.24	1.89	30.24	35.00	50.50	*3.4*
2740	Olds & Whipple, Hartford	E. P. Brewer, Silver Lane	.72	6.16	.28	29.86	35.00	46.33	*4.1*
2757	H. A. Sheldon, West Suffield	F. C. Root, Suffield	.16	4 85	1 55	15.57	35.00	26.83	*8.6*
2862	Sold by H. K. Brainard, Thompsonville	Station Agent	2.22	5.87	2.40	23.37	33.00	41.37	*3.5*
2863	Frank Culver, West Suffield	F. C. Root, Suffield	.17	4.61	2.13	14.16	35.00	25.03	*9.5*
2865	C. L. Spencer, Suffield	F. C. Root, Suffield	.80	3.02	7.58	23.39	35.00	36.91	*5.6*
2866	C. L. Spencer, Suffield	J. E. Hastings, West Suffield	.70	7.49	2.30	22.62	35.00	40.43	*4.8*
2867	C. L. Spencer, Suffield	A. J. Easton, Suffield	.22	4.89	1.72	22.24	35.00	35.07	*6.0*
2868	Allen Wilson, Suffield	Arthur Sikes, Suffield	1.71	7.63	1.70	17.56	35.00	35.94	*5.7*
2869	Allen Wilson, Suffield	Arthur Sikes, Suffield	1.01	4.83	3.42	22.16	35.00	36.83	*5.6*
2870	H. N. Loomis, West Suffield	F. C. Root, Suffield	.26	5.66	2.06	19.96	35.00	33.69	*6.3*
2888	C. L. Spencer, Suffield	J. H. Ford, Suffield	.21	7.27	1.77	25.73	35.00	43.18	*4.4*
2906	Olds & Whipple, Hartford	Station Agent	1.44	6.30	.54	33.49	35.00	52.16	*3.5*
2867	James Van Gelder, Suffield	F. C. Root, Suffield	trace	5.37	1.83	15.04	35.00	26.83	*8.7*
2969	Dudley Webster, West Suffield	F. C. Root, Suffield	.64	8.61	.56	23.22	35.00	42.03	*4.5*
3058	J. E. Soper & Co., Boston, Mass.	H. S. Frye, Poquonock	trace	7 69	.43	25.24	30.00	42.00	*3.6*

Miscellaneous Fertilizers and Manures.

Cotton-Hull Ashes.

In the table on the preceding page, are tabulated 25 analyses of Cotton-Hull Ashes analyzed during the present year. It will be seen that the highest percentage of potash in these samples is 33.49, the lowest 14.16, and the average 22.3 per cent. The actual cost of potash per pound (valuing the water-soluble and and citrate-soluble phosphoric acid at 8 and 7½ cents per pound respectively, and insoluble phosphoric acid at 2 cents) has ranged from 9½ cents to 2½ cents, or 5.4 cents per pound on the average, or about half a cent per pound less than it costs in sulphate of potash.

Only potash soluble in water is determined in the analyses. That insoluble in water has little immediate value.

A complete analysis of Cotton-Hull Ashes is here given, which shows the state of the different ingredients as regards solubility.

Cotton-Hull Ashes.—*Complete Analysis.*

	Soluble in in water.	Insoluble in water.	Total.
Potash (K_2O)	25.20	2.65	27.85
Soda (Na_2O)	.50	.80	1.30
Lime (CaO)	none	5.23	5.23
Magnesia (MgO)	.20	11.04	11.24
Oxide of iron and alumina	none	1.64	1.64
Phosphoric acid (P_2O_5)	1.52	8.29	9.81
Sulphuric acid (SO_3)	2.32	0.09	2.41
Carbonic acid (CO_2)	8.28	3.31	11.59
Chlorine	.21	none	.21
Silica and sand	.16	9.34	9.50
		water and charcoal	19.27
	38.39	42.39	100.05
Deduct chlorine equivalent to oxygen			.05
			100.00

Wood Ashes.

2692. Ashes from hard wood. Sampled and sent by D. Fenn, Milford.

2736. Canada Ashes. Sampled and sent by W. H. Burr, Westport, from a lot bought by him of J. B. Nash, Westport, for $11.50 per ton.

2850. Screened Canada Ashes. Sampled by Station Agent from stock of C. S. Gillette, Cheshire. Price $11.00 per ton.

2935. Ashes from stock bought by T. R. Dawley, Griswold, of Ezra Chazy, Baltic, for 20 cents per bushel. Sampled and sent by Station Agent.

2715. Damp Wood Ashes from the Coe Brass Mfg. Co., Torrington. Sampled and sent by C. H. Eno, Simsbury. They contain 15.3 per cent. of water.

3010. Screened Wood Ashes from James Hartness Soap Co., Detroit, Mich. Sampled and sent by N. S. Platt, Cheshire, from stock purchased by him. Guaranteed to contain 5 per cent. of potash.

ANALYSES.

	2692	2736	2850	2935	2715	3010
Potash, soluble in water	4.50	3.69	3.71	4.30	1.96	4.40*
Phosphoric acid	2.70	1.61	1.45	2.32	2.09	1.63

* Total potash 5.27.

The unleached ashes which are in market now are of considerably poorer quality than they were in former years.

LIME KILN ASHES.

2076. Sampled and sent by D. E. Peck, Whigville.

Water	19.54
Carbonate of lime	49.00
Lime chiefly as hydrate	4.11
Phosphoric acid	.49
Potash	.48
Coal and other matters by difference	26.38
	100.00

LIMESTONE.

2970. White with crystalline structure, **2971** gray, from Canaan.

ANALYSES.	2970	2971
Insoluble in acids	.15	.48
Oxide of iron and alumina	----	.20
Lime	56.02	31.31
Magnesia	----	21.03
Carbonic acid by difference	43.83	46.98
	100.00	100.00

2970 is practically pure carbonate of lime, the mineral calcite. **2971** is a mixture of carbonate of lime and carbonate of magnesia, the mineral dolomite.

Land Plaster.

2806. Nova Scotia Plaster, sent by Robt. Aitkin, Shaker Station.

2887. Cayuga Plaster sent by E. P. Halley & Co., Coscob.

Analyses.	2806	2887
Pure hydrated sulphate of lime	96.99	65.40
Carbonate of lime	2.27	27.27
Other matters by difference	.74	7.33
	100.00	100.00

Tank Water and Settlings.

2712. Water in which bones have been boiled to remove grease. Sent by C. A. Sanderson, Moodus.

2704. Waste Scouring Solution from wool scouring works.

2705. Sediment from Tanks in which wool is scoured. Both sent by J. A. Bill, Lyme.

Analyses.	2712	2704	2705
Water	----	----	32.33
Sand	----	----	50.78
Organic matter	----	.55	6.72
Nitrogen	1.14	.02	.14
Phosphoric acid	----	trace	.15
Potash	----	.16	.69

Wool Waste.

2968. A sample of Wool Waste sent to the Station by some one in the State, whose name and address have been mislaid, thus making a report to him impossible when the analysis was completed, contained

Nitrogen as ammonia	.38
Nitrogen, organic	6.75
Total nitrogen	7.13
Phosphoric acid	.14
Potash	.14

Some forms of wool waste have proved to be valuable as nitrogenous manures and others are quite inert. This material was damp and seemed to be already rotting, so that it may be presumed that the nitrogen in it was becoming available.

Farm Manure.

2754. Cow Manure. From milk cows fed on hay and stover, —one feed of each per day—corn meal, wheat bran and a moderate quantity of brewers' grains. The manure was kept closely packed in a manure house having a cement floor.

2755. Hog manure from swine fed on garbage and corn meal. Manure exposed to the weather in the sties. The extraordinary quantity of phosphoric acid in the manure comes from the bone contained in the garbage.

Samples of both these manures were drawn by an officer of the Station with all possible care. The manure was from a lot used in field experiments at the farm of J. H. Webb, Esq., Hamden, and will be again referred to in the discussion of field experiments.

Analyses.

	Cow Manure.	Hog Manure.
	2754	2755
Water	82.42	65.23
Organic and volatile matters	15.33	25.73
Ash	2.27	9.04
	100.00	100.00
Contained in the Ash:		
Potash	.300	.102
Soda	.114	.111
Lime	.280	1.476
Magnesia	.121	.119
Oxide of iron and alumina	.063	.488
Phosphoric acid	.204	.808
Sulphuric acid	.075	.171
Chlorine	.123	.054
Sand and silica	.990	5.711
	2.270	9.040
Contained in the organic and volatile matters:		
Nitrogen as ammonia	.10	.02
Organic nitrogen	.32	.56
Total nitrogen	.42	.58

Rockweed and Sponge.

Some species of marine plants are more or less used on the coast as fertilizers, and are thought much of for corn land; particularly the "round-stalked rockweed" and "flat-stalked rockweed," for which farmers sometimes pay 5 cents per bushel in its green state as it is cut from the rocks at low tide. It is plowed

under green, and is popularly believed to lose much of its valu if allowed to dry before turning under.

Analyses of several species have been made, the samples bein supplied by Mr. Walter Merwin, of Milford, March 24.

2724. Round Stalked Rock-Weed. *Ascophyllum nodosum.*

2725. Flat Stalked Rock-Weed. *Fucus vesiculosus.*

2726. A coarse Sponge. Species not determined.

2727. A finely branching Sea Weed. Species not determined

2728. "Irish Moss." *Chondrus crispus.*

ANALYSES.

	Rockweed round-stalked.	Rockweed flat-stalked.	Sponge.	Sea Weed.	Icelan Moss
	2724	2725	2726	2727	272
Water	82.71	84.34	86.13	81.39	80.8
Organic and volatile matters	13.52	12.09	5.46	12.72	14.4
Pure ash	3.97	3.57	8.41	5.89	4.7
	100.00	100.00	100.00	100.00	100.0
The organic matter contains nitrogen,	.53	.48	.58	.73	.7
The ash consists of—					
Potash	.61	.54	.16	1.30	1.0
Soda	.90	.85	.72	.58	
Lime	.30	.27	.08	.23	
Magnesia	.24	.23	.14	.18	
Oxide of iron and alumina	.01	.02	.23	.12	
Phosphoric acid	.10	.09	.14	.18	.1
Sulphuric acid	.82	.67	.17	.84	
Chlorine	.80	.82	.77	.96	
Sand and silica	.12	.16	6.17	1.72	.5
Other matters by difference	.05	.10	----	----	
	3.95	3.75	8.58	6.11	
Deduct oxygen equivalent to chlorine,	.18	.18	.17	.22	
	3.77	3.57	8.41	5.89	

The analyses show as large a percentage of nitrogen in all the samples as is contained in good stable manure, but less phosphoric acid. The "rock weeds" have as much potash, and the fine sea weed and Irish moss a good deal more than ordinary stable ma nure. In the opinion of those who use rock-weed, fresh, it is as quick in its action as stable manure. Some maintain that Rock weed gathered in the fall is best. Others prefer the spring-crop.

No attempt was made to determine the small quantity of iodine which the samples probably contain. With the volatile matter is included a portion of the sulphur which the seaweeds contain in considerable quantity.

Direct determinations of total sulphur made in samples Nos. **2724** and **2725** gave .43 and .34 per cent. respectively of sulphur in the fresh substance.

Pigeon Manure.

2649. A dry sample, containing very little foreign matter, feathers, straw, etc. Sampled and sent by A. D. Cooke, Hartford.

Analysis.

Water	9.55
Organic and volatile matters*	62.38
Potash	1.07
Soda	.65
Lime	2.12
Magnesia	.79
Oxide of iron and alumina	1.08
Phosphoric acid	1.83
Sulphuric acid	.57
Chlorine	.47
Sand and silica	18.12
Carbonic acid and undetermined	1.37
	100.00
*Containing nitrogen as ammonia	.47
Organic nitrogen	3.43
Total nitrogen	3.90

This material contains as much or more nitrogen than most commercial fertilizers, besides 1 per cent. of potash and 1.8 per cent. of phosphoric acid. The "dung" of fowls contains not only the undigested food, but also, in solid form, the excretions of the kidneys, which in cattle are voided as urine, and are apt to be lost, both by drainage and by rapid fermentation. This, the richer food, and the fact that the dung of fowls is comparatively dry, explain the higher percentage of nitrogen, phosphoric acid and potash in it.

REVIEW OF THE FERTILIZER MARKET.

For the Twelve Months ending Dec. 31, 1890.

Nitrogen.

Nitric Nitrogen.

The *wholesale* quotation of nitrogen in nitrate of soda has fallen very decidedly during the year. The average price during the first five months of 1889 was 16.1 cents per pound, for the

same period in 1890 the average price was 11.9 cents. In December, 1890, it was quoted at 11.2 cents per pound. See monthly quotations on page 79.

The *retail* price of nitrogen in nitrate of soda in this State during the last season has been about 16 cents per pound.

Ammonic Nitrogen.

The *wholesale* price of nitrogen in sulphate of ammonia was about a cent lower per pound during the first five months of 1890 than during the same period in 1889. But from July on, the wholesale price in 1890 has ruled about a cent higher in 1890 than in 1889. This has been caused in part by the unusual demand for ammonia for ice-machines during the last summer. The wholesale price of nitrogen in this form in December, 1890, was 16½ cents per pound. See monthly quotations on page 79.

The *retail* price of nitrogen in sulphate of ammonia in this State the past year has been about 18 cents per pound.

Organic Nitrogen.

The wholesale price of nitrogen in Dried Blood has also been decidedly lower in 1890 than in the previous year. Thus for the first five months of 1889 the average *wholesale* price of nitrogen in blood was 16.1 cents per pound; for the same months in 1890, 11.9 cents per pound. It was quoted in December last as 11.2 cents. The monthly quotations are given on page 79. Very little dried blood has been retailed in Connecticut the past year.

The wholesale quotations of nitrogen in Azotin have followed the same changes as in Blood, always being a fraction of a cent higher.

Dried Fish Scrap, which is considerably used in mixed fertilizers, was quoted in January, 1889, at $22.50 per ton, but has steadily fallen to $19.25.

As has been already noticed in this report, nitrogen has retailed in this State the past year at 15.5 cents per pound in Blood, from 15.6 to 16.8 cents in Castor Pomace and from 11.7 to 13.8 cents per pound in Cotton Seed Meal. Cotton Seed Meal still remains the cheapest source of available organic nitrogen.

Phosphatic Materials.

Refuse Bone Black, quoted at the beginning of the year at $19.45 per ton wholesale fell to $18.50 in September at which price it is still quoted.

Rough and Ground Bone have been quoted at $21.50 and $26.50 per ton wholesale through the whole year.

Ground Charleston Rock, quoted at wholesale in January at $11.25 per ton fell to $10.65 in July, $9.75 in August and has been quoted at the same figure ever since.

Acid Phosphate, containing 14 per cent. available phosphoric acid, was quoted at 81¼ cents per unit, equivalent to 4.06 cents per pound for available phosphoric acid, in January. It fell in July to 73¾, equivalent to 3.7 cents per pound for available phosphoric acid, and is still quoted at that price.

Potash.

Muriate of Potash.

The wholesale quotations of this article show smaller fluctuations than those of any other commonly used fertilizer. They have varied between 3.55 cents per pound for actual potash in December last and 3.64 cents per pound, the quotation during all the earlier part of the year.

Actual potash in the form of muriate has been retailed in Connecticut at about 4.2 to 4.4 cents per pound.

Double Sulphate of Potash and Magnesia.

The wholesale quotation remained steady at 4.42–4.44 cents per pound for actual potash till November, when it fell to 4.27 and in December rose to 4.53.

The retail price in Connecticut this year has been a little less than 6 cents per pound.

High-Grade Sulphate of Potash.

This material contains about the same per cent. of potash as the muriate but is almost entirely free from chlorine. The wholesale quotation made actual potash cost 4.77 cents per pound from January to September. Under the new tariff law it is imported duty-free, and in consequence the price fell to 4.17 cents in October, and 4.06 cents in November. In December it rose again to 4.31. It has not been retailed in Connecticut during the past season.

Kainit.

The wholesale price of Kainit rose from $10.70 per ton in January to $11.00 in April, fell to $10.37½ in July, remained steady till December and then fell to $10.00.

In general nitrogen in blood, azotin, nitrate of soda and fish scrap has fallen decidedly in price during the year. The nitrogen of sulphate of ammonia has, on the other hand, risen considerably.

Charleston Rock is considerably lower, Bone Black somewhat lower, Bone has remained constant through the year.

Acid phosphate made from South Carolina rock is considerably lower than at the opening of the year.

Muriate of Potash, Double Manure Salt and Kainit are quoted about as they have been through the year, but high-grade sulphate is very considerably lower.

The market quotations given above are taken from the "Oil Paint and Drug Reporter," published in New York. The weekly quotations for each month are averaged, and this average is taken as the quotation for the month.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review:

Phosphate rock, kainit, bone, fish-scrap, tankage, and some other articles are quoted and sold by the ton. The seller usually has an analysis of his stock and purchasers often control this by an analysis at the time of purchase.

Sulphate of ammonia, nitrate of soda and muriate of potash are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

Blood, azotin and ammonite are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the percentage of ammonia by 14 and divide that product by 17). A "unit of ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain 8½ units of ammonia, and if quoted at $2.25 per unit, a ton of it will cost $8\frac{1}{2} \times 2.25 = \$19.13$.

The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given :

Ammonia at	$3.00	per	unit is	equivalent to nitrogen at	18.2	cts. per lb.
"	2.90	"	"	"	17.6	"
"	2.80	"	"	"	17.0	"
"	2.70	"	"	"	16.4	"
"	2.60	"	"	"	15.8	"
"	2.50	"	"	"	15.2	"
"	2.40	"	"	"	14.6	"
"	2.30	"	"	"	14.0	"
"	2.20	"	"	"	13.4	"
"	2.10	"	"	"	12.8	"
"	2.00	"	"	"	12.2	"
"	1.90	"	"	"	11.6	"
"	1.80	"	"	"	11.0	"

Commercial Sulphate of Ammonia contains on the average 20.5 per cent. of nitrogen, though it varies considerably in quality. With that per cent of nitrogen (equivalent to 24.3 per cent. of ammonia).

At	4	cents per lb.	Nitrogen	costs	19.5	cents per lb.
"	$3\frac{7}{8}$	"	"	"	18.9	"
"	$3\frac{3}{4}$	"	"	"	18.3	"
"	$3\frac{5}{8}$	"	"	"	17.6	"
"	$3\frac{1}{2}$	"	"	"	17.0	"
"	$3\frac{3}{8}$	"	"	"	16.4	"
"	$3\frac{1}{4}$	"	"	"	15.8	"
"	$3\frac{1}{8}$	"	"	"	15.2	"
"	3	"	"	"	14.6	"
"	$2\frac{7}{8}$	"	"	"	14.0	"
"	$2\frac{3}{4}$	"	"	"	13.4	"

Commercial Nitrate of Soda averages 95 per cent. of the pure salt or 15.6 per cent. of nitrogen.

If quoted at	3	cents per lb.	Nitrogen costs	19.2	cents per lb.
"	2⅞	"	" "	18.3	"
"	2¾	"	" "	17.6	"
"	2⅝	"	" "	16.9	"
"	2½	"	" "	16.0	"
"	2⅜	"	" "	15.2	"
"	2¼	"	" "	14.4	"
"	2⅛	"	" "	13.6	"
"	2	"	" "	12.8	"
"	1⅞	"	" "	12.0	"
"	1¾	"	" "	11.2	"

Commercial Muriate of Potash and also High Grade, 98 per cent., Sulphate of Potash usually contain 50½ per cent. of actual potash.

If quoted at	2.60	cents per lb.	Actual Potash costs	5.15	cents per lb.
"	2.50	"	" "	4.95	"
"	2.40	"	" "	4.75	"
"	2.30	"	" "	4.55	"
"	2.25	"	" "	4.45	"
"	2.20	"	" "	4.35	"
"	2.15	"	" "	4.25	"
"	2.10	"	" "	4.15	"
"	2.05	"	" "	4.06	"
"	2.00	"	" "	3.96	"
"	1.95	"	" "	3.86	"
"	1.90	"	" "	3.76	"
"	1.85	"	" "	3.66	"
"	1.80	"	" "	3.56	"
"	1.75	"	" "	3.46	"
"	1.70	"	" "	3.36	"

The Double Sulphate of Potash and Magnesia has about 26½ per cent. of actual potash.

If quoted at	1.00	cent per lb.	Actual Potash costs	3.77	cents per lb.
"	1.05	"	" "	3.96	"
"	1.10	"	" "	4.15	"
"	1.15	"	" "	4.34	"
"	1.20	"	" "	4.53	"

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since July, 1887. The price given for each month is the average of the four weekly quotations in that month. Sulphate of ammonia is assumed to contain 20.5 per cent. and nitrate of soda 15.6 per cent. nitrogen, and muriate of potash 50½ per cent. of actual potash or 80 per cent. of the pure salt.

Wholesale Prices of Fertilizing Materials.

		Cost of Nitrogen at wholesale in				Cost of Potash at wholesale in			
		Blood. Cents per pound.	Azotin or Ammonite. Cents per pound.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia. Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate of Potash. Cents per pound.	Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
1887.	July	13.1	14.0	12.0	14.5	3.41	---	---	---
	August	12.6	13.4	11.8	14.5	3.40	---	---	---
	September	12.1	12.5	12.2	14.7	3.36	---	---	---
	October	12.1	12.3	13.0	14.9	3.36	---	---	---
	November	11.8	12.2	12.7	14.7	3.41	---	---	---
	December	12.1	12.3	13.8	14.9	3.46	4.08	---	---
1888.	January	12.2	12.3	13.8	14.9	3.48	4.24	---	---
	February	12.6	12.6	13.3	14.9	3.48	4.49	---	---
	March	13.9	13.6	13.1	14.9	3.46	4.15	---	---
	April	13.9	13.6	12.9	14.9	3.46	4.11	---	---
	May	13.9	13.6	12.8	15.2	3.52	4.24	---	---
	June	14.0	13.6	13 1	14.9	3.50	3.86	---	---
	July	14.2	13.9	13.1	14.9	3.50	3.86	---	---
	August	14.5	14.2	13.2	14.9	3.50	3.86	---	---
	September	14.6	14.2	13.9	15.3	3.71	4.38	---	---
	October	15.0	15.0	14.1	15.8	3.71	4.47	---	---
	November	15.9	16.2	14.6	16.4	3.72	4.48	---	3.89
	December	16.0	16.5	15.2	16.4	3.71	4.53	---	3.89
1889.	January	16.3	16.6	15.1	16.6	3.66	4.63	5.00	4.30
	February	16.5	17.0	15.0	16.6	3.66	4.44	5.01	4.37
	March	16.5	17.1	15.2	16.6	3.66	4.48	4.88	4.20
	April	16.0	16.1	14.6	16.2	3.57	4.44	4.85	4.10
	May	15.1	15.2	13.8	15.7	3.64	4.49	4.65	4.06
	June	14.9	14.6	12.8	15.2	3.64	4.53	4.60	4.06
	July	14.6	14.2	12.5	15.1	3.64	4.53	4.56	4.06
	August	14.6	14.2	11.9	15.0	3.64	4.53	4.56	4.06
	September	13.9	14.2	12.1	15.0	3.64	4.44	4.66	4 06
	October	13.6	13.7	12.2	15.0	3.64	4.44	4.67	4.06
	November	13.2	13.6	12.3	15.4	3.64	4.44	4.75	4.06
	December	12.6	13.3	12 4	15.4	3.64	4.44	4.98	4.06
1890.	January	12.2	12.7	12.1	15.4	3.64	4.44	4.97	4.06
	February	12.1	12.5	12.0	15.4	3.64	4.44	4.97	4.06
	March	11.9	12.2	11.9	15.4	3.64	4.44	4.89	4.06
	April	11.5	12.2	11.2	15.4	3.64	4.42	4.77	4.06
	May	11.6	12.2	11.2	15.3	3.62	4.42	4.77	4.05
	June	11.6	12.1	11.2	15.8	3.62	4.42	4.77	4.00
	July	11.6	12.0	11.2	16.6	3.62	4.42	4.77	3.69
	August	11.3	11.5	11.0	16.6	3.62	4.42	4.77	3.69
	September	11.0	11.3	11.1	16.6	3.62	4.42	4.77	3.69
	October	11.1	11.7	11.6	16.5	3.62	4.42	4.17	3.69
	November	11.2	11.4	11.6	16.5	3.55	4.27	4.06	3.69
	December	11.2	11.4	11.6	16.5	3.62	4.53	4.31	3.69

REPORT OF THE MYCOLOGIST,

DR. ROLAND THAXTER.

DURING the past season the injury from fungus diseases was much less than in the previous year owing to the absence of warm damp weather through the early summer, which was more than usually dry and therefore unfavorable for their development. For this reason several experiments which had been planned were necessarily abandoned for lack of material to work with, and the attention of the mycologist has been for the most part divided between further trials of fungicides for the treatment of certain fungus diseases, and an investigation of the "potato scab," which proved of such considerable interest and importance that it has been made the special subject of inquiry during the season. An elaborate experiment in regard to the effect of certain chemicals upon the "onion smut," in continuation of last year's work on the same subject, proved almost valueless owing to the failure of the seed; and further greenhouse experiments do not point to the conclusion that more favorable results, from the sulphur treatment, are to be looked for than were obtained during the season of 1889.

The success which has attended the use of fungicides by the Station has led the writer to give somewhat more specific directions for their preparation and use, as an extension of Bulletin 102 issued by the Station in March, 1890. The importance of the injuries due to fungi and known under such names as blight, rust, mildew, etc., and the fact that many of them are readily remedied does not receive sufficient recognition in the State, which should not be behind other farming communities both in this country and abroad in reaping the benefit of whatever information is obtainable on the subject. The present opportunity is therefore taken again to urge farmers to communicate with this department of the Station, and to furnish information where serious damage is being done to their crops through injuries of the nature just referred to. Attention is called to the photographic reproduction facing p. 99, which shows very well what may be

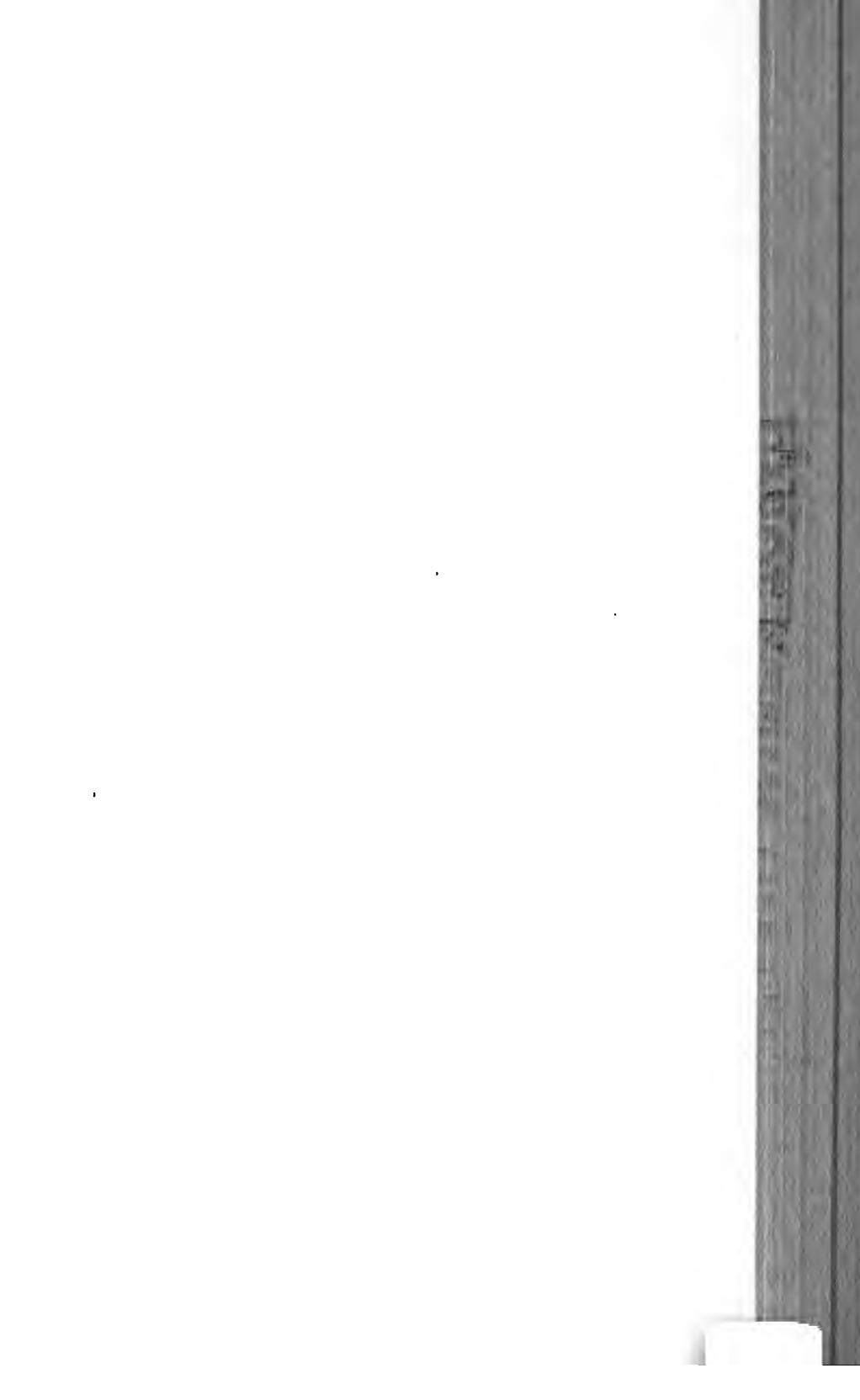


Fig. 1.

Specimen of ordinary "deep" Scab.

Fig. 2.

"Deep" Scab, induced by inoculation, in form of monogram R.

done at small expense to prevent premature defoliation of fruit trees by fungi; and also to the fact that treatment applied to grapes this year has resulted in a difference equivalent to that between a nearly full crop and an almost total failure. Such demonstrations, supported by similar results in various sections of the country, show that farmers can no longer afford to neglect the subject of fungus diseases and their treatment, and it is hoped that greater interest in it may be shown during the coming season and more frequent calls made for information from the Experiment Station.

THE POTATO "SCAB."*

It is a well-known fact that the theories and explanations which have been advanced to account for certain diseased conditions of the surface of potato tubers generally known as "Scab," are nearly as numerous as the experimenters who have studied the disease, but until quite recently no satisfactory demonstration of what the active agent really is which gives rise to the condition, has been advanced; although the subject has occupied scientific investigators from time to time for upwards of half a century.

The recent demonstration just referred to is that of Mr. H. L. Bolley, which was published in Agricultural Science, Vol. IV, p. 243, having been previously presented as a paper at the meeting of the American Association for the Advancement of Science, Aug. 26 of the present year. Mr. Bolley's work was so carefully done and his results appear to be so conclusive in bearing out his statement that the disease originates from the action of a specific bacterium, that the subject might seem exhausted and not open to further investigation. The observations of the writer, however, begun without any knowledge of Mr. Bolley's work, although they do not, as will be seen, disprove the accuracy of his investigations, have nevertheless led to quite different results which seem to show that the question "what is potato 'Scab'" is still a very pertinent one.

It is hardly necessary to remark that the investigation of the writer has been in a great measure preliminary, having been commenced about midsummer of the present year, and is based largely

* The substance of the present notice was presented in a paper by the writer read before the botanical section at the meeting of the Association of Agricultural Colleges and Experiment Stations at Champaign, Ill., Nov. 12, 1890.

on greenhouse cultures, which were necessarily made on a small scale; work upon the subject out of doors not being possible at the time when the organism producing scab had been isolated and obtained pure by artificial cultures in sufficient quantities for inoculations. Experiments of a practical nature, therefore, were not attempted and the main object in view has been to isolate, and if possible to demonstrate what is the active agent in causing the disease investigated. Having, in the writer's opinion at least, succeeded in doing this pretty conclusively, a rational basis is gained for practical experiments which will be undertaken at the Station during the coming year.

The theories which have been previously held concerning the origin or cause of "Scab" may here be briefly alluded to; although for further information on the subject the recent papers of Prof. Humphrey* and Mr. Bolley† should be consulted; the latter especially containing a very full bibliography of the subject.

Among the causes of an inorganic nature which have been said to produce the disease may be mentioned the following: *Excessive moisture* in the soil, supposed to affect the lenticels, which constitute the small rough dots scattered over the surface of normal tubers, producing an abnormal growth of corky tissue at such points, which may extend to the adjacent superficial tissue and be associated with more or less decay. *Mechanical irritation* induced through foreign substances in the soil which may act as a direct irritant to the surface of the tubers; the "Scab" being the result of an attempt to repair the injury through an abnormal corky growth at such points; also accompanied or followed by more or less decay. *Chemical action* due to the presence of certain substances in the soil, such as lime or oxide of iron, which through an irritant action might lead to similar results. *Fertilization* especially by stable manure which has been definitely observed to influence the prevalence of the disease; a fact which has been explained on the supposition that it may furnish conditions favorable for the action of one or more of the supposed causes already enumerated.

It is needless to examine these different theories in detail, since in all cases they lack the confirmation of crucial experiments and are involved and involve each other in a mass of contradictions, with a result of nothing definite in any case. The simple fact

* Report of the Mass. Agr. Exp. Station 1889, p. 131, and 1890, p. 214. † l. c.

at scab occurs very commonly on light dry land entirely free om extraneous material which could produce external irritation, d regardless of lime or other chemical substances in the soil; so that barn manure, not infrequently at least, yields a clean op, is sufficient to show clearly that none of these supposed uses is in itself sufficient to account for the phenomenon. The est that can be said of them is, that in some cases they may volve conditions favoring the prevalence of the disease; but e question of its cause they leave untouched.

Turning to the theories which connect the "scab" with the tion of some organism, vegetable or animal, the "insect" the- y is one very commonly entertained, especially by farmers, insects" including earth worms. This idea is based upon the ct that scab spots form an attractive feeding ground for a vari- y of insects, especially wire worms, myriapods and mites, the ommon occurrence of which, especially in the deeper scab spots, as led to the belief that the two were directly associated. That is is not the case has been shown by careful observation, the ly connection between the two resting on the fact that the in- ry already existing from a quite different cause is often ex- nded by them very considerably.

On the botanical side perhaps the earliest explanation of the use of scab is that of Dr. Wallroth,* who in 1842 attributed to the action of a fungus which he called *Erisybe subterranea*. his fungus, however, which is a conspicuous form and very adily recognized, is now known to have no connection with the dinary forms of scab and has not even been found in this coun- y. The disease which it produces, although having some re- mblance to scab in its earlier stages, is yet quite distinct and eculiar, and is more properly known as "smut" of potatoes; e fungus developing in the diseased tubers beneath the skin, hich finally cracks, liberating a powdery greenish mass of large, ulticellular spores. The same thing appears to have been de- ribed and figured as "*Protomyces*" by Martius,† by Berkeley‡ *Tubercinia scabies*, and distributed, according to Smith,§ by abenhorst as *Rhizosporium solani*. It was placed in the genus *rosporium* by Fischer de Waldheim‖ under the name *S. scabies*

* Linnæa, 1842, p. 332.

† De Aardappel-Epidemie etc. Genootsch. v. Landb. en Kruidk. t. Utrecht, 1843.

‡ Jour. Roy. Hort. Soc., vol. 1, 1846, p. 33, fig. 30–31 [Sec. Smith].

§ Diseases of Field and Garden Crops, p. 35.

‖ Aperçu System d. Ustilagineés, 1877, p. 33.

and is there retained by Saccardo,* although Dr. Wallroth's name would appear to be the oldest.

Beyond general allusions to a possible fungus origin this so-called smut is apparently the only true fungus which has been in any way suggested as a cause of any scab-like disease of potato tubers. Within a few years, however, Dr. Brunchorst† of Sweden, claims to have shown that a disease of potatoes occurring in that country, which he considers identical with the ordinary and destructive forms of scab, is due to one of the Mycetozoa or slime-fungi, allied to that producing the club root of cabbage. This organism, which he calls *Spongospora solani*, has not been found associated with any American form of the disease; and Prof. Humphrey is doubtless correct in his opinion, based partly on photographs of diseased tubers sent by Dr. Brunchorst, that the latter's "*skurv*" and our "scab" are quite different diseases.

The most recent contribution concerning the cause of scab from a botanical standpoint is that of Mr. Bolley, already referred to, which embodies the first experimental demonstration of a definite cause of scab that has yet been given. This author shows through careful experiments, by means of inoculations from pure cultures, that the specific agent in his disease is a species of Bacterium which he found always associated with it; and which when used as a medium for inoculations under proper conditions reproduced the disease in growing tubers. It is to this group of what may be called "vegetable" theories that the writer is constrained to add yet another as a result of his observation and experiments.

General Characteristics of the Disease.—The disease as it occurs in Southern Connecticut, where the writer has had an opportunity of examining it, first shows itself as a minute, reddish or brownish spot on the surface of the tuber, often making its appearance when the latter is very young, and sometimes not until it has reached a considerable size. This discoloration very commonly, though not invariably, has its origin in one of the roughened points, or lenticels, which are scattered over the surface of the potato, and after it has once appeared may extend quite rapidly to the adjacent tissue; becoming deeper in color and being associated with an abnormal corky development of the parts involved which often cover a considerable area. This area may

* Sylloge, vii, 513.

† Ueber eins uhr. verbr. Krankheit d. Kartoffelknollen. Bergens Museum Aarsberetnung, 1886: p. 217–226. Bergen, 1887.

onstitute a more or less irregular scab-like crust over the surface
r more frequently may become deeply cracked and furrowed,
he depth and extent of the injury depending in a great measure
pon the stage at which the tuber first became diseased; those
hich are attacked while very young showing, as might be ex-
ected, by far the most deep seated injury. The presence of bac-
erial decay together with the growth of various forms of sapro-
hytic fungi, for which such diseased spots form a congenial sub-
tratum, serve to extend the injury very considerably, especially
hen the tubers are left in the ground for some time after matu-
ity. Under such conditions also the work of injury is completed
ery frequently by various insects, more especially by wire
orms, myriapods and mites, which feed upon the decaying por-
ions of the tuber till the cavities may be scraped quite clean
own to the sound tissues; so that the surface may present the
ppearance of a succession of rounded pockets. In severe cases
here, however, there has been little extension of the injury by
nsects the potato presents the appearance figured on Plate I, fig. 1.

The description just given may seem superfluous, the described
ondition being so familiar; yet it has seemed best to give it in
onsideration of the uncertainties which are attached to the
eaning of the term "scab," partly as a result of the numerous
eories held concerning it, and partly on account of actual dif-
erences presented by the disease itself.

The attention of the writer was first specially attracted to this
bject in July of the present year after examining a number of
e tubers in various stages of the disease in question which were
rought to the laboratory from the town of Hamden. It was
en noticed that the majority of diseased spots on these tubers
ere associated with the presence of a peculiar grayish mould-
ke appearance, especially prominent about the edges of the
ounger spots and frequently discernible without the aid of a
and lens. An attempt was made at the time to transfer a por-
on of this gray substance to a slide, in order to gain some
nowledge of its true character by examining it under the micro-
cope; but the attempt was unsuccessful, the substance seeming
disappear when touched with a needle. Scrapings from the
iseased surface, where this film was observed, when placed un-
er the microscope showed nothing characteristic which could be
dentified as connected with the object sought for, and the same
sult attended the examination of sections cut from the scab

spots. The subject was then laid aside for a time until, on visiting the field from which the potatoes in question had been brought, it was found that the diseased tubers, which constituted a large percentage of the crop, in almost every case showed the more or less distinct presence of the same grayish material previously observed. In fact it was invariably visible in the younger spots when due care was taken to uncover the potatoes so as to avoid unnecessary friction, and to examine them while still moist. When rubbed against the earth, or when the surface was allowed to become dry, the gray material was often found to have disappeared entirely. Having ascertained that the appearance described was not local in any part of the field, but was present wherever diseased potatoes were examined, a number of the latter on which it was most conspicuous, were placed, while still moist, in a tight tin box where they were left for twenty-four hours or more. At the end of this time the gray growth was found to have greatly increased ; being visible to the naked eye on all the scab spots, and no difficulty was met with in taking enough of it on a needle to make sure of recognizing it under the microscope. It was then found to consist of bacteria-like bodies with a strong tendency to cohere in an amorphous-looking mass, very repellant of water and even to some extent of absolute alcohol. The bodies themselves were rod-like, of various lengths, and among them numerous spirally-coiled forms were peculiar and conspicuous. Pressure on the cover glass, applied to separate the mass, caused it to break up entirely into bacillus-like pieces exactly resembling a group of minute bacteria.

After examining a number of fields affected by the disease in different localities, and finding that this gray organism was its invariable accompaniment when once recognized and sought for, usually visible to the naked eye when due care was taken in removing the tubers from the ground, its isolation and cultivation were undertaken, and by a few transfers it was finally obtained quite pure. The nutrient media used for this purpose were gelatine and agar peptone broths and potato decoctions, sterilized slices of potato being also used for the same purpose. Drop cultures were made in Van Tieghem cells, in which decoctions of horse dung or of potato were used as the nutrient fluids. In all these substances, both fluid and solid, the organism was found to grow with vigor.

General Characters of the Scab fungus when cultivated.—The gross appearance of the cultures on solid media should be noted, since it is quite peculiar and varies considerably according to the substance used. In all cases the growth of the organism when it is in direct contact with the air is accompanied by a peculiar dark stain, although when a culture is made so that the growth takes place wholly within the nutrient medium, little or no discoloration is produced. This stain is very characteristic, and varies considerably in intensity according to the substances used for cultivation. On slices of potato as well as on potato agar or potato gelatine decoction it is very striking—smoky black, almost opaque, and diffuses itself to a considerable distance from the point of growth. On gelatine peptone broth the stain is dark rust brown, while on agar peptone broth it is comparatively pale. As the culture grows old the stain loses its intensity, diffusing evenly through the jelly, which becomes reddish brown and more or less translucent.

In all cases a neutral medium is the best for cultures. Slight alkalinity, and to a less degree slight acidity, appear to retard the growth. This is strikingly shown in liquid cultures made on a large scale, in which also the changes of color are very marked. The connection between the black discoloration and some alkaline product formed by the growth of the fungus seems evident, since both neutral and acid solutions are made alkaline by it after the black discoloration has begun. In the latter case the solution retains its natural yellowish color until its acidity is overcome. Alkaline salts readily impart a brownish color to potato decoction; but it is far less intense than that produced by the fungus, and a solution already thus stained is only slightly changed by the fungus, or changes very slowly.

The gross appearance of the organism itself is also quite peculiar and somewhat variable, being most characteristic on the potato bases. On potato slices it tends to become heaped up so as to form a blackish, viscid-looking, lobulated pustule, without spreading to any great extent over the surface on which it grows. On potato agar it produces a circular, lichenoid, livid brownish growth extending evenly over the surface in all directions, slightly convex, firm and viscous-looking, with scalloped margin and radial and concentric furrows. On agar peptone broth the growth is less convex and less characteristic; in some cases viscid and slightly lichenoid, but usually covered with a white, floccu-

lent stratum which eventually turns grayish, and resembles exactly the grayish film originally found in connection with the scab spots, both in appearance and microscopic characters, and constitutes the "fructification" of the fungus. This fructification may make its appearance at points on any solid culture medium, especially when the latter has become somewhat dry; but potato agar cultures may grow for months without showing any sign of it, the growth remaining smooth and viscid-looking over its whole surface.

The life history of the Scab fungus, as shown by a microscopic examination of the drop cultures and those on solid media, is briefly this. One of the longer or shorter rods or spirals, or any portion, however small, torn from the ordinary vegetative filaments, when placed in a nutrient medium, produces directly an intricately branched mass of extremely fine filaments, from five to eight or nine ten-thousandths of a millimeter in diameter, which grow in all directions in short, irregular curves. In water no septation whatever is visible in the vegetating filaments; but on the application of iodine, divisions are seen at irregular intervals giving the appearance of septation, which may perhaps be only spurious. Under certain conditions these filaments may grow up into the air and become spirally coiled at their extremities, and subsequently rather closely septate, may break up into a mass of short pieces resembling bacteria, at the same time turning from white to gray in gross appearance. In addition to this form of fructification, certain bodies, apparently resting spores, are sometimes formed, especially in liquid media, when the fungus is subjected to unfavorable conditions. These bodies are produced in the continuity of the filaments, especially at their extremities, are roundish or oval, refractive and much like spores of bacteria in general appearance. Their germination, however, has not been observed, and it is possible that they may not be reproductive bodies.

Inoculations made with the Scab fungus.—These pure cultures were not obtained until after the opportunity for using them in making inoculations out of doors had passed; but in the meantime, as a matter of curiosity, infections were made by transferring as small a portion of the gray material as could be taken on the point of a sterilized needle, directly from the diseased potatoes, to a number of sound ones which were found to be still growing out of doors at the time. The tubers to be infected

were carefully uncovered, washed with distilled water, and a cavity made around them so that they could be covered by a pane of glass, which was in turn covered with a few inches of soil. The tuber lying exposed in the cavity could thus be readily examined at any time by removing the earth and looking through or raising the glass. Some half dozen hills were thus treated, from one to three potatoes being exposed and infected in each hill. Within three days after the inoculation the point at which the tuber was touched by the needle began in every case to show the characteristic symptoms of the disease, and subsequently developed into scabs similar to those from which the infection material was obtained, and accompanied by the same gray organism. This experiment was of course valueless as a test inoculation, not only from the fact that the material used was not known to be pure, but because very many of the potatoes in the neighboring hills were subsequently found to be diseased in the same way, and it is merely mentioned as in a measure confirmatory of the results of subsequent inoculations made under more strict conditions.

There was fortunately available at this time a small lot of sprouting potatoes obtained from a greenhouse experiment of the previous winter. These tubers were planted at once in three small greenhouse borders affording about eighteen small hills for experiment, and by the first of October tubers were formed in them large enough for inoculation experiments. One or more of these tubers were then uncovered in each hill, and were treated as above described in connection with the inoculations made out of doors. They were then inoculated with pure material of the scab organism taken from the agar peptone broth cultures, the aerial "fructification" on these cultures being more convenient for the purpose than the tough, stroma-like crust on the remaining substrata. The inoculations were made in two ways; in the one case by using a stiff platinum wire as a needle in transferring the infection material, by which a slight injury was inflicted on the epidermis of the tuber at the point of contact, and in the other by using a piece of very thin platinum foil cut to a long slender point, by means of which the scab organism could be transferred without any such injury to the epidermis. In the majority of cases the infection material was placed upon the surface of the tuber at a single point; but in others, as a means of showing an unquestionable and direct connection between the process of infection and whatever results might arise from it, the

material was applied at a definite series of points, forming circles, lines, curves or letters, as shown in fig. 2 of Plate I., where the monogram R. T. was employed for this purpose.

Two sets of infections were made at an interval of five days in order to compare the periods which might elapse between the infection and the first appearance of any effect which it might produce upon the surface of the tuber. As in the infections made out of doors, the effect of the inoculation became manifest within three or four days by the appearance of the characteristic brown stain in every potato infected; with one exception in the case of a nearly mature tuber in which none of the several points infected showed any diseased condition of the adjacent tissues. In the other cases the infection was apparent at every point of application, with few exceptions where the continuity of lines was interrupted by the failure of a point here and there. The infection was most certain where the epidermis was slightly injured at the point of contact or where this point was a lenticel; but in very young tubers three-quarters of an inch or less in length an entrance seemed to be effected at any point of the surface without reference to lenticels or any injury. In one case more particularly a potato of some white, smooth skinned variety, was infected in the form of a letter R when a little more than half an inch long, the material being placed on its surface so as to inflict no injury and the definite area of discoloration and corky growth which resulted was an unbroken reproduction of the letter. This particular specimen was kept uncovered under its glass plate until it had grown about a third larger than when infected, after which it was cut from the stem and put in alcohol. It was found, however, that the method of experiment employed was open to a serious objection in that the tubers, shortly after they were uncovered, ceased to grow, or grew only slightly, so that the diseased spots resulting from the infection, reached no considerable dimensions, although after about a week all showed the usual corky formation together with more or less cracking of the surface and were visibly accompanied by the gray organism as in the specimens obtained out of doors. For this reason several tubers, on which the infection was seen to have taken, were hilled over on the eighth day and left buried for a fortnight. At the end of this time they were again uncovered, and were found to have made considerable growth while the diseased spots had become much larger and more prominent, resembling in all respects the ordinary deep scab.

In these two sets of greenhouse infections, twenty-two potatoes were infected as above described, and the disease was reproduced in them all, with only one exception already mentioned in the case of a nearly full grown tuber which showed no signs of disease at the point of application, although the infection was accompanied by a slight injury to the epidermis. This failure was probably due to the age of the potato when infected, since a tolerably rapid growth appears necessary, as would be expected, in order to produce well-marked scabs; although it might be accounted for by variations in the susceptibility to the disease of different varieties of potatoes. It may be mentioned further that the infected potatoes, while uncovered, showed no spots of disease at other points than where the material was applied, and the same was true in the majority of those which were subsequently covered. The potato infected in the form of a monogram, for example, reproduced on Plate I., was absolutely without a flaw over its whole surface apart from the direct results of infection. In two or three cases, however, where the potatoes were covered, a spot of scab appeared here and there near the original point of infection. Such spots may, of course, have had an independent origin, but were probably due to the fact that a little of the scab organism was brushed from the original point of infection in covering the tuber.

Of the thirty-six uninfected tubers which were obtained when the hills were finally dug, five showed from one to several scab marks each. Of these, two were exposed in cavities where other tubers were infected and may have become diseased in this way, while the other three were undoubtedly independently affected. Since, however, the remaining thirty-one were quite clean, the presence of so small an amount of independent infection cannot be said in any way to vitiate the general results obtained.

Summary.—To summarize the writer's observations, then, it may be said, that whenever he has examined the disease out of doors it has invariably been found to be visibly accompanied by the growth of an undetermined fungus, at least in its earlier stages, and that this fungus when cultivated in an absolutely pure condition on nutrient substrata and thence transferred to growing tubers with the necessary precautions, reproduces in them the disease called scab, from which it was originally obtained, the observations and experiments made so far being convincing, to the writer at least, that the two are directly associated as cause and effect.

This may seem too positive a statement; based as it is on necessarily limited experiments which cover so short a period of time, not even including a single growing season, in the face of equally positive statements to the contrary by previous investigators. Prof. Sorauer* for example remarks that "one finds in and on the dead tissue divers kinds of fungi, but none which attack the sound tissue." Again, Prof. Arthur says in his report† upon the subject, "no particular kind of fungus or small animal, in truth no fungus or animal at all can be found invariably to accompany the injury at any particular stage of its development," and Prof. Humphrey who has recently conducted careful experiments on the subject in Massachusetts concludes‡ that "no organism of any sort was found constantly or even frequently present at any stage of its progress and there can be no doubt that it is not the result of the activity of the development of any living thing other than the potato plant."

That a particular kind of fungus *does* invariably accompany the injury studied by the writer, at least in its younger stages, he has satisfied himself by careful examination in the field, and in this respect he feels that his observations have been sufficiently extended to warrant a positive contradiction of the statement that such is not the case. That this fungus does attack the sound tissues is certainly indicated by the infection experiments above described, neither can it be said that the diseased condition is merely a result of the activity of the tuber, except in so far as this is true of any disease accompanied by abnormal growth in or near the tissues involved.

"Deep" and "Surface" Scab compared.—It will doubtless be asked how the results just described are to be reconciled with equally positive results obtained by Mr. Bolley which have been previously referred to, and what explanation can be given of the fact that the scab fungus, although so conspicuous and easily recognized by its accompanying stain, was not observed in any of the latter's cultures. This apparent contradiction arises, in the writer's opinion, from the fact that, although Mr. Bolley appears to have demonstrated the bacterial origin of the form of scab which he has investigated, he is in error in one important particular, namely, in assuming that the disease he has studied so

* Pflanzen-krankheiten, Band 1, p. 231.

† 6th Ann. Report of N. Y. Agr. Exp. Station, 1887, p. 344.

‡ 7th Ann. Rep. Mass. Agr. Exp. Station, 1889, p. 220.

ably includes all the diseased conditions commonly known in this country under the name of "scab." As a matter of fact, there appear to be two quite different diseases, very similar in general appearance, which have been distinguished by Prof. Humphrey as "deep" and "surface" scab, although still considered by this writer as merely variations of the same affection. In the "surface" form the corky modification of the diseased tissues is much more prominent than in the "deep" form; producing a slight elevation, in the beginning at least, on the surface of the tuber; and appears much less inclined to give rise to general decay resulting in the pockets characteristic of the deep form. This latter, even in its earlier stages, is apt, when the surface of the tuber has dried off, to produce a depression rather than an elevation, and the diseased area is rather scaly or scab-like than evenly corky, as in the earlier condition, at least, of the surface form. The deep form, again, is always accompanied by a more or less prominent discoloration, which becomes dark and pronounced as the disease progresses, and is undoubtedly owing to the staining action of the scab fungus already referred to. The fungus seems to be much more rapid and corrosive in its action than the bacterium, a fact which may account for the presence of a more abundant corky growth in connection with the latter, which its less rapid action would render possible. This is also indicated by the usually more deep-seated and serious character of the fungus injury, as well as by the fact that the bacterium, as Prof. Arthur informs me, is unable to produce any effect unless applied to the tuber while very young; whereas the fungus can be made to produce a marked effect upon good-sized growing tubers, as is shown in fig. 2, Plate I., the tuber represented having been two-thirds grown when inoculated.

It is necessary to state, however, in connection with what has just been said, that the writer's experience with "*surface*" scab has been very limited, and that he can speak with certainty from sufficient personal observation only concerning the so-called deep form. As a matter of fact, the surface form was not observed in any of the fields where the deep form was injurious, and only a few specimens of it were received among a quantity of tubers affected by the deep form which were sent to the Station from Guilford. These specimens together with a few others, for which the writer is indebted to the kindness of Messrs. Arthur, Bolley, and Humphrey, are all the material available upon which

to base an opinion. Insufficient though it be, however, it shows a distinct variation in the type of the disease, and the assumption that such a difference really exists is apparently the only rational explanation which can be brought forward to account for successful inoculation experiments both with the fungus and with the bacterium.

The fact that the deep and surface forms often occur side by side on the same tuber, as in the specimens received from Prof. Humphrey, seems to be entirely explicable, and in no way calculated to throw doubt on the probable existence of the two distinct diseases above characterized. That the deep form if distinct should not occur in the west in company with the surface form is hardly to be believed, in view of the ease with which such a disease would naturally be disseminated through the yearly movements of the crop. It is therefore somewhat remarkable that the fungus should not have appeared in any of Mr. Bolley's cultures, unless it may be explained by his avoidance, in seeking material for cultivation, of such scabs as were "blackened or pitted,"* pitting and blackening being, as already mentioned, characteristics of the fungus disease.

Botanical Relations of the Scab Fungus.—In regard to the true position of the fungus of deep scab nothing definite can be said, and a more detailed account of it from a botanical point of view, together with figures of its microscopic and gross appearance, is reserved for another year, when more definite information concerning its botanical relations may be available. Except for its apparently true branching and aerial "fructification," it reminds one strongly of some of the polymorphic bacteria, for which it was taken when first observed. The two characters just mentioned seem, however, to exclude it from the bacteria; but where among the Hyphomycetous fungi it can be properly referred is a question concerning which no botanist to whom it has been referred has been able to give any information. Possibly it may be found in some such ill-defined genus as *Oospora*. That it or its prototype has not been already described seems very improbable, since a fungus resembling it closely in microscopic characters and general mode of growth is one of the commonest forms of mould among the many species which appear upon barnyard manure and dung and rubbish of all sorts. This common form, however, does not produce the black stain upon its

* Bolley, l. c., p. 277.

ubstratum so characteristic of the scab fungus, and further liffers from it in the great abundance of its "fructification" on nedia upon which the scab form produces none at all. Otherwise, it resembles it so closely that the two can hardly be distinguished microscopically. In two cultures of this form on potato elly a slight blackening was observed after several weeks, but it vas comparatively faint and not comparable to the deep stain vhich appears in cultures of the scab form in a few days.

The writer will be glad to receive notes of observations on this ubject, or specimens of the different varieties of scab from any one interested.*

MISCELLANEOUS NOTES.

Diseases of Tomatoes.—For some reason not readily explained Tomatoes in various localities have, during the latter portion of he last season, been greatly injured by the attack of various fungi, which in 1889 did no special damage to the crop. The nost noticeable injury was done by the fungus of the Potato Rot (*Phytophthora infestans*) which not only attacked the eaves so as to do considerable damage, but appeared with virulence upon green and even partly ripe fruit, causing it to turn brown and black, and producing decay. The same fungus was also observed in Maine, destroying green tomatoes early in October, although the writer has not previously noticed that it attacked them. Should this taste for tomatoes be perpetuated, it will be necessary to resort to Bordeaux mixture or carbonate of copper in order to save the September crop. It is unlikely, however, that it will become permanently serious.

In addition to the *Phytophthora* considerable injury was done locally by the brown *Cladosporium fulvum* upon the leaves, which was much more virulent than in the previous year, in some instances killing the vines completely, towards the end of September.

The tomatoes themselves have also suffered to an unusual degree from several fungi which, like the fungus of potato rot, may attack them before or after they are ripe. Of these the two most injurious appear to be *Macrosporium Tomato*, Cke. and

* Since the above was in press a second set of infections with the scab fungus have been made successfully in the greenhouse. Infections with the similar organism obtained from horse dung have given no result. Concerning the latter, Prof. Saccardo writes that it may be doubtfully referred to his *Oospora perpusilla*.

Fusarium Lycopersici, Sacc., the former producing roundish decayed areas which become covered with an olive-brown or black velvety coating of the *Macrosporium*. The *Fusarium* usually appears on the ripe fruit, especially where it has cracked, forming a thick coating of mould, at first white then reddish salmon colored. The injury of these fungi may be decreased by gathering and burying the tomatoes as soon as they show signs of disease. If left in the field they are sure to communicate the disease to the sound tomatoes.

Fungus Disease of Tomato worms.—Although numerous insects are known to be subject to the attack of parasitic fungi of various kinds, the smaller forms are usually the greatest sufferers and the writer was therefore surprised to find a destructive epidemic among the tomato worms (*Phlegethontius Carolina* and *P. Celeus*) infesting a field in the vicinity of New Haven. The same field had been largely stripped of its foliage by the worms in the previous year; but this season sustained comparatively slight injury owing to an epidemic caused by an *Empusa* similar in nature to the fly fungus so common in houses during the late summer and autumn. When this field was examined the epidemic was nearly at an end, very few larvæ remaining; but the owner stated that the dead tomato worms were hanging on the vines in large numbers a few weeks previous, as was attested by numerous blackened remains still adhering to the stems. A small lot of larvæ just killed by the disease was, however, obtained, from which the character of the affection could be ascertained. Just before death the larvæ become slightly milky, changing to greenish-yellow after death and collapsing to a greater or less extent. A few hours after death the fungus appears as a whitish coating on the skin and an enormous number of spores are discharged. The presence of a fungus in the case would hardly be noticed without a hand lens, as the hyphæ barely project beyond the integument and are very inconspicuous. As the spore discharge ceases the larvæ become rapidly soft and flaccid turning black and putrid. The fungus is the same (*Empusa Grylli* form *aulicæ*) which is common on hairy caterpillars and has also been found this year on a number of naked cut-worm larvæ (*Lithophane*, *Mamestra* and *Agrotis*). It was found easy to propagate it on young tomato worms, which died after the usual period of incubation (six to ten days,) with the characteristic symptoms. This is the first instance recorded of an *Empusa* upon larvæ of any of the Sphingidæ.

Fungus Disease of Grape leaf hopper and Cabbage worms.—During September the Grape leaf hoppers (*Tettigonia vitis*), which were abundant and causing no little injury to the grape leaves in Mr. Coe's vineyard at Meriden, were found to be attacked in great numbers by another species of *Empusa*, which eventually destroyed them entirely. At the same time a single specimen, rather old, of the Cabbage worm (*Pieris rapæ*) was found at New Haven infested by apparently the same fungus; a circumstance which suggested to the writer a repetition of an experiment performed several years before, by which a single cabbage worm had been successfully inoculated with the disease transferred from the apple leaf hopper (*Typhlocybe mali*). The matter was of some economic interest from the fact that the *Empusa* in question is destructive to numerous noxious insects and would be perhaps the most available species to employ should it be found practicable to use such fungi as a means of artificially spreading disease among injurious insects.

Twelve small *Pieris* larvæ were selected and confined for a day with several of the diseased leaf hoppers from which there was an abundant discharge of spores. The larvæ were then fed in a crystallizing dish and grew rapidly. The weather was very cool at the time so that the period of incubation was considerably lengthened; nevertheless, between the eighth and thirteenth day all of the larvæ had died and were found to be filled with the resting spores of the fungus, with the exception of one specimen which was killed by parasitic insects (*Pteromalus*) soon after infection. What appears to be the same *Empusa* has been kindly sent from New Jersey by Prof. Halsted, on *Pieris* larvæ, and the same fungus is reported to have killed vast numbers of the clover weevil in the same locality during the past season.

Peronospora on Cucumbers.—The occurrence of *Peronospora Cubensis*, B. C. on cucumbers may be noted as of interest in extending the range of this peculiar species, which was first found in Cuba, then in Japan, and quite recently in New Jersey and several other localites in this country. It produces yellow spots upon the leaves which resemble the injury of the melon aphis; but did not seem to be very injurious at South Manchester where it was first observed.

Mildew of Lima Beans.—This mildew (*Phytophthora Phaseoli*) described and figured in last year's report, has been again destructive this year and has made its appearance in a number of

new localities in the neighborhood of New Haven. So far as ascertained it extends from New Haven to Hartford and west to South Norwalk, but has not yet been discovered outside of Connecticut. Its serious nature is indicated by the damage it has done during so unfavorable a season as that of 1890, and farmers are again strongly advised to use the precautions for keeping it in check mentioned in the Report of this Station for 1889, p. 171.

Rust of Pears.—The several varieties of pear of the Japanese strain (*Kefir*, etc.) have shown themselves very susceptible to injury by one of the rusts derived from the red cedar; the particular "cedar apple" which in this case has its third or Roestelia stage on pears, being what is known as *Gymnosporangium globosum*, a form which also produces rust in Connecticut on Hawthorn, Apple, Quince, etc., but does not attack the ordinary varieties of Pear. The fungus forms dull red orange spots on the pear leaves early in the season, the finger-like Roestelia stage developing from the under side of these spots during August and September. The presence of this fungus interferes with assimilation, and when severe produces premature defoliation. The trouble may be decreased by cutting down neighboring cedars as far as possible or by spraying with fungicides immediately after rains in May.

Mildew on Buckwheat.—A mildew which appears to be the form described by Peck as *Ramularia rufomaculans* on another member of the same family (*Polygonaceæ*) has been observed in several localities on Buckwheat. It does considerable injury, attacking the lower leaves first and spreading upwards, stunting the growth of the plant and impairing the quality as well as diminishing the quantity of the seed. Nothing can be recommended for its prevention beyond burning of all stubble and refuse, and rotation with some other crop.

Clover Rust.—This rust, which was incorrectly referred to in the last Report as caused by *Uromyces striatus*, proves to be *U. Trifolii* Wint. and has been very abundant this year. Its æcidial stage was not uncommon on white clover during June.

Rye rust and smut.—*Puccinia rubigo-vera*, D. C. has been unusually abundant on Rye this year, covering the leaves with its rust colored Uredo-form and doing considerable injury. The Rye smut also (*Urocystis occulta*, Rabh) has been very common, though not enough so to be very injurious.

Quince Orchard, showing results of treatment with Bordeaux Mixture for the "leaf spot" (Photo Oct. 31.)

Adjacent rows in same orchard, showing results of no treatment, (Photo Oct. 31.)

PLATE III.

SOME RESULTS FROM THE APPLICATION OF FUNGICIDES.

Leaf-spot of Quince (*Entomosporium maculatum*, Lév.)

The leaf-spot of quince has become a very serious trouble in Connecticut as well as elsewhere, and the writer knows of at least one large orchard which has been entirely abandoned from this cause. The Station has therefore made several tests of the efficacy of fungicides in this disease with results which may be seen by reference to Plates II. and III. of the present report, which show the effects of treatment and no treatment respectively, and represent exactly the condition of treated and untreated rows side by side in the same orchard as they were photographed by the writer on October 31.

The appearance and results of the disease are too well known to need description; but it may be mentioned briefly that the fungus in question forms small reddish-brown spots on the leaves and fruit, which extend with considerable rapidity, turning rust-colored on the leaves and causing them to fall prematurely, even as early as July. Such defoliation not only exhausts the tree and prevents the fruit from maturing, but hinders the proper maturing of the next year's buds.

The principal experiment upon this disease was made at Milford, where Mr. Geo. F. Platt kindly afforded facilities to the Station for the treatment of a part of his orchard, another part being left untreated. The orchard in question is arranged in rows of about fifteen large, thick bushes each; and of these, two rows were treated with Bordeaux mixture and two with the ammoniacal carbonate of copper, both of these substances being prepared according to the formulas given on pp. 110–112. The method of application is shown on Plate IV, the fungicide being carried in a hogshead set in an ox cart or single wagon, and the force-pump (Gould's double-acting) mounted directly on the hogshead. The Vermorel nozzle, with its cap-hole reamed, was used, carried on the end of light ¼-inch linen insertion tubing supported on a light pole, as in the figure. By standing in the cart and driving between the rows all parts of the bushes were easily reached. Two persons to spray, one on either side, and one to drive and pump, allowed of very rapid work; which is essential in any spraying in order to take advantage, as far as possible, of fine weather, so as to be sure that the substance sprayed will be thoroughly dried on the foliage before it is subjected to rain.

The quinces in question were sprayed only *four* times, once just before they bloomed, May 17; once as soon as the blossoms had fallen, June 2d; again on June 25th, and for the last time on July 28th. The month of July was unusually dry, otherwise a fifth application would have been necessary about the middle of this month. As it was, however, this small number of applications served to retain the foliage completely on the rows sprayed with Bordeaux mixture, as may be seen by reference to the Plates just mentioned. The rows sprayed with carbonate of copper were, however, not as well protected, saving only about 80 per cent. of their foliage, while the untreated portions retained only from 10 per cent. to *none* of their foliage. Unfortunately, whether owing to the defoliation of previous years or to causes which led to the general failure of fruit to set during the past season, the greater part of the young quinces fell off through the whole orchard soon after the blossoms had fallen; so that the effect of spraying could only be observed on the comparatively small amount of fruit which remained on the treated bushes. On the untreated bushes no fruit matured, except here and there a small, gnarled specimen; while, as Mr. Platt informs me, the fruit from the treated rows was unusually large, fair, well-flavored and juicy.

There can therefore be no question of the efficacy of the Bordeaux mixture in this disease, and it will be of interest to compare the effects of previous treatment and its absence, in connection with further trials which are planned for the coming season.

The writer also sprayed a number of quince bushes with the Knapsack Hydronette, in the orchard of Mr. N. S. Platt at Cheshire. Only three applications were made—one May 9th, which was much too early; one May 31, which was much too late; and one June 24. Despite the fact that the applications were not made at proper times and were so few in number, Mr. Platt writes under date Oct. 24: "As to the Quince trees you sprayed, they are still well covered with leaves, while all the others in the orchard are practically bare."

Black Rot of Grapes.

Mr. Coe has continued spraying for this disease in his vineyards in Meriden during the past season with very conclusive results, especially in the lower vineyard, which for several years past has been completely devastated by black rot, except when it

was most thoroughly sprayed in 1889. The important precaution was taken this year of ploughing between the rows and covering the ground directly under the vines with earth enough to bury whatever diseased grapes might have fallen the previous year. The applications of Bordeaux mixture were made three times: once just before the vines blossomed, once just after the fruit had set, and once the last week in June, and were followed by two applications of ammoniacal carbonate of copper about the middle and last of July. As a result of this treatment the crop from the main portion of the vineyard was almost perfect, and when examined in September showed only here and there a cluster with a few diseased berries. Two rows were left untreated as checks, but were given one spraying by accident, so that they did not fairly show the advantages derived from the treatment. In these rows hardly a single cluster was unaffected by the rot, and a great majority of them were ruined for marketing purposes or wholly destroyed. Another section was treated twice with ammoniacal carbonate of copper and then neglected, and in this case also the great majority of the clusters were destroyed.

The use of the ammoniacal carbonate of copper was found entirely satisfactory in obviating the injury done by late treatment with Bordeaux mixture through its adherence to the grapes when harvested, no stain being left upon the clusters, which were quite clean with a perfect bloom when harvested in September.

In this connection attention may be called to the report of Prof. Chester on this subject based on his experiments at the Delaware Experiment Station (Bulletin X), which is especially valuable from the financial summary which he is able to give from detailed memoranda of one of his experiments. In this case 879 vines were sprayed four times with Bordeaux mixture and once with carbonate of copper and carbonate of ammonia mixture at an expense of labor and material amounting in all to 3 cents per vine for four applications. The net income per vine was 75 cents, leaving a balance of 72 cents per vine to be laid to the credit of the treatment.

It may be mentioned that the most critical period in this State seems to be about the last of June, the disease beginning its worst visible inroads about the 10th of July. The last spraying in June is therefore a very important one and should be made thoroughly and above all things in time, say by the 25th.

Anthracnose of Grape.—At the writer's suggestion the usual treatment for this disease was tried by the Connecticut Valley Orchard Co., with the result of a very marked improvement in the condition of the vines and in the yield of marketable grapes. The vines were very severely trimmed, all possibly diseased wood being cut out and burned, and then treated with a strong (25 per cent.) solution of sulphate of iron. The vines were subsequently sprayed with Bordeaux mixture and carbonate of copper as for the black rot. This year's experiments indicate that this disease can be successfully treated, though more serious than black rot. The severe trimming and winter treatment, either with a strong solution of sulphate of iron, or of sulphate of copper (one pound to twenty gallons) are both of the first importance and practically indispensable in contending against it.

Leaf spot of Plums and Cherries causing defoliation.—This disease, often called the "gunshot injury," is very generally injurious in the State to plums and cherries, defoliating them prematurely. Mr. Coe repeated the application made last year to several large plum trees, thereby preserving their foliage intact. The Bordeaux mixture was also used by the Valley Orchard Co. for plums and cherries with similar results, while a few trees left untreated lost their foliage in July.

Potato Blight.—Mr. N. S. Platt writes from Cheshire in regard to this disease. "We applied one spraying of Bordeaux mixture to some late potatoes about Aug. 10, a full week after the blight had made its appearance in the field. Five rows thus treated kept green three weeks after the others were dead and black. At digging, about Sept. 24th, the treated rows were much the best in size and practically free from rot. The untreated rows were smaller and considerably decayed. The measurements at digging were:

Untreated	3½ bushels per row.
Treated	6 bushels per row."

Strawberry Rust.—A section of Mr. Atwater's strawberry bed in Cheshire was sprayed to ascertain the effect of Bordeaux mixture on the leaf spot of strawberry. Bordeaux mixture was applied once May 9, just before the plants came into blossom, and ammoniacal carbonate of copper was applied on May 31, just after the bulk of the fruit had set. Neither mixture adhered well and very little, if any, difference could be observed between the

treated and untreated portions, which were both not greatly injured by the fungus.

Trials have also been made with fungicides against Black Knot of plums, Anthracnose of beans, and Mildew of peas, but further observations are necessary before making any report upon them.

Further Experiments on the "Smut" of Onions.—In the last report the writer gave the results of the season's experiments upon onion smut, which indicate that an application of flowers of sulphur sown with the seed, on very smutty land, would increase the yield in a ratio of about 34 to 7 where no sulphur was applied. In order to test the matter more fully further experiments were made in a greenhouse border infected with smut spores, the object being to discover whether a more direct application of the sulphur than was previously made might not give better results than were previously obtained. The relative proportions, however, between the number of onions surviving in the treated and untreated rows remained about the same (5 to 1). A larger experiment was also tried at Greens Farms, the fungicides being sown directly with the seed by means of a hopper cleverly devised by Mr. Guyer. This contrivance, however, was not found adapted to use in the field, although working to perfection on a smooth floor, and constant shaking and pounding was necessary to produce any flow of the fungicide, which was therefore not only distributed very unevenly, but failed entirely in many sections of the rows. In addition to this the seed also failed in a great measure, not more than from 10 to 20 per cent. coming up. The experiment was therefore practically valueless, although even under these conditions the ratio in favor of the sulphur treatment was 25 to 8. Sulphide of potassium gave a slightly better result, and sulphide of calcium showed only very slight differences; while muriate of potash, muriate and lime, and hyposulphite of sodium gave no favorable results whatever.

This experiment, although in itself of little value, when taken in connection with those previously made, seems to indicate that no greater advantages will be gained by using the sulphur treatment than were previously reported, and whether this advantage is sufficient to recommend its use to those troubled by the disease is for them to decide.

A single point of interest was ascertained in connection with the greenhouse cultures, namely the ability of seedlings showing smut at isolated points near the top of the first leaf to recover

entirely from the disease. This fact indicates that the first leaf is susceptible to infection by the germinating smut spores, while it is being pushed up through the ground, and that the collar of the embryo can hardly be the only point thus susceptible since recovery would hardly be supposable in this case. Substances applied for treatment must therefore act not only about the seed, but in the earth through which the first leaf is pushed.

FUNGICIDES AND THEIR APPLICATION.

The present notice is designed to call the attention of farmers to the importance of gaining some practical knowledge of the use of fungicides and to furnish brief directions for this purpose. More detailed information on the subject adapted to special cases will be furnished by the Station on application, and when practicable, personal attention will be given in such cases if desired.

The advantage resulting from the application of fungicides has been so thoroughly and repeatedly demonstrated in connection with the diseases of the grape and various other similar affections that their use may be recommended without reserve in such cases. In many of the most serious diseases of this nature it is absurd any longer to talk of "experimenting" for their prevention by fungicides. Their prevention by this means is an established fact, and in no sense a theory or probability, the truth of which is still in doubt. Such "experiments," therefore, in many cases, are now quite superfluous in connection with the general demonstration that we have the means for such prevention, and are justified only as local object lessons or with a view to improving in some way upon the means or methods already known and approved. Such local object lessons are, however, of very great importance and utility for the reason that farmers are naturally conservative in their attitude towards unfamiliar modes of procedure connected with their calling, and are inclined to demand an ocular demonstration in such cases. Object lessons of this kind, in so far as they can be carried out by the Experiment Station, must necessarily be very limited in number, and farmers are therefore urged to experiment for themselves, not only by spraying for the prevention of fungus diseases, but of insect depredation as well, since the treatment of both can often be combined by mixing the fungicide with an insecticide. The Station, however, does not recommend anyone who has had no

PLATE IV

Method of Spraying Orchards with Double Acting Pump and Vermorel Nozzles.

previous experience, either personally or from personal observation, to attempt spraying on a large scale unless under supervision; but rather to experiment on a small scale at first; so that by making a direct comparison between the results of treatment and no treatment, he may form an opinion as to the value of the application from his own experience.

It is very necessary, however, that even a small experiment should be made intelligently and thoroughly. Anyone who thinks he can do such work without previously informing himself on the subject had much better let it alone, since he is quite as likely to fail as to succeed, and thus to mislead others as well as himself. The first requisites for success in spraying, are a definite knowledge of the disease which it is proposed to treat, of the proper means to use for the purpose, and of the proper manner of using such means. Many persons imagine that all that is necessary is to get some of the fungicide on the leaves no matter how or when. As a matter of fact the "how" is of the first importance. Always in the case of fungicides and in the majority of cases in the use of insecticides a proper spraying nozzle, like the Vermorel, which will give a uniform and very fine spray is *an absolute necessity.* *All* the foliage to be treated must be wet and *not drenched.* It is quite impossible to gain this end by using an ordinary rose spray nozzle or by holding one's thumb over the mouth of a common straight nozzle. Such means ensure great waste as well as an uneven distribution of the material used, which, under these conditions, is sure to injure by drenching the foliage to which it is applied if such injury ever accompanies its use. A proper nozzle and force pump, properly mixed materials and a knowledge of the proper times for applying them in the particular case in which they are to be used, are three prime essentials for success in spraying, and if either one is disregarded success need not be expected.

Information relating to the subject should not be sought in manufacturers' circulars, which are quite as likely to mislead as to be of service; but from some authoritative source, such as the publications of Experiment Stations, or of the proper section or sections of the United States Department of Agriculture, supplemented, if possible, by personal correspondence. Such action will lead to the avoidance of all sorts of mistakes connected with the operation and greatly increase the chances of success.

Nozzles.—For all general purposes of spraying the *Vermorel* nozzle is by far the best, being adapted for liquids having substances in suspension as well as for those which are clear, and may be employed for all kinds of spraying. When used in connection with a force pump of fairly good power, the orifice in the cap through which the spray is driven, may be reamed out to twice the size of the largest hole in either of the two caps (coarse and fine) which accompany each nozzle, and thus far quicker work can be done, the spray obtained in this way being far more copious and abundantly fine. The hole must be enlarged with a reamer, *not* with a drill, since the orifice must flare to produce the broad funnel-shaped spray peculiar to this nozzle.

The *Nixon* nozzle produces a copious and direct smoky spray by driving a small stream through a fine gauze cap, and is unsurpassed for spraying *clear* liquids. Having no means by which, like the Vermorel nozzle, it may be readily cleared when it becomes clogged, it is not available for liquids like Bordeaux mixture having substances in suspension, and since the majority of liquids used are not clear, it is much less generally useful than the Vermorel.

The ordinary rose or "fine spray" nozzles, such as are advertised by most dealers, are generally useless or inefficient for the desired purpose.

Hose, for spraying must be light, so as to be readily carried on a pole as shown in Plate IV. The best kind for the purpose is what is known as *linen insertion tubing* (¼ inch), which combines lightness with durability and cheapness. The hose should be attached to a light pole of sufficient length to reach above the foliage to be sprayed, so that the spray may be directed downwards upon it. In order to control the duration of the spray without trouble it will be found convenient to screw a short piece, about a foot long, to the end of the pole, so that it will turn easily on the screw. Then drive two nails into the pole in such a position that this piece can only turn the distance of a right angle, that is, from a position at right angles to the pole to a position in which it is in line with the pole. Then fasten the end of the hose, together with its attached nozzle, firmly to the end of this piece, the base of which should also be attached to the hose passing over it. In this way the nozzle and hose move with the piece and can be made to turn at any angle, from a straight position adapted for direct spraying, to a position at

right angles for downward spraying, by simply turning the pole on its axis. The hose should be fastened by a loose loop once to about the middle of the pole, around which it may be conveniently wound once or twice. By holding a turn of the hose between one hand and the pole a slight pressure will stop the flow of liquid, when desired, as effectually as a stop-cock.

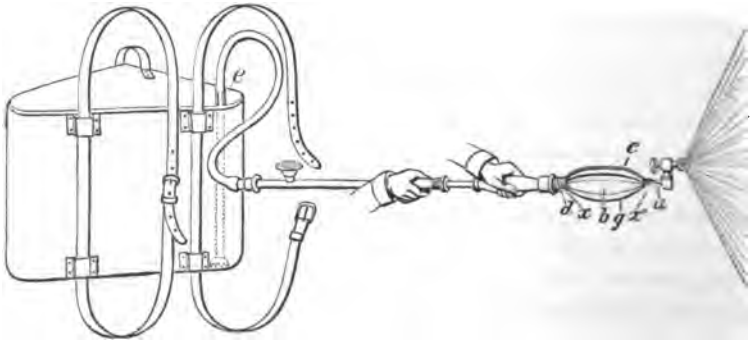
Pumps.—For a stationary pump which is to be mounted on a hogshead or other vessel containing the substance to be sprayed and drawn from place to place, when needed, on wheels or in some vehicle, any good force pump will answer. A double-acting force pump fitted with couplings on both sides, to which two sets of hose may be attached (or three sets if one side is fitted with a Y-coupling), is very much the most useful form of pump for spraying on a large scale. Where a Y-coupling is used one set of hose may be turned into the hogshead and fitted at the end with a very small orifice, through which a fine stream may be discharged that will keep the mixture constantly stirred, while the other two sets are left free for use with nozzles, thus allowing a discharge of spray on both sides from a vehicle driven between two orchard rows, as shown in Plate IV.

The Station has used for this purpose Gould's double-acting spraying pump, which is shown in operation in Plate IV, and is powerful, while at the same time simple and compact, being easily taken apart and readily carried by one person. A Y-coupling can of course be used with a single-acting force pump, allowing the use of two sets of hose for spraying, if the stirring is done by hand : the double-acting pump is much more convenient, and not more expensive.

For spraying on a small scale, or where a mounted hogshead cannot be driven, some apparatus combining a supply of the material with a proper force pump is the most convenient. A comparatively inexpensive machine of this sort, devised by Mr. Galloway, and said to be convenient and effectual for the purpose, may be made by any brass worker or obtained as stated at the end of this article. This machine consists of a tank carried on the back and containing the force pump as well as the liquid to be sprayed, the pump being worked by a lever passing over the right shoulder, while the spraying lance, fitted with an improved Vermorel nozzle, is held in the left hand.

The writer has used for the same purpose during the last two years, a home-made apparatus which, with slight improvements,

has proved very satisfactory and effective during the past season. This consists in a copper tank of convenient shape for carrying on the back, to which is adjusted an ordinary Aquanette or Hydronette hand force pump, as shown in the figure. For the wash boiler figured in Bulletin 102 of this Station, is substituted a copper tank similarly shaped, but smaller and more convenient, which with a tin cover can be made for a price ($3 or less) considerably below that of the smallest size of wash boiler. The tank used at the Station is made, as a matter of convenience, considerably larger than necessary, for the purpose of allowing the Hydronette pump to be carried in it. This tank, which holds when full about six gallons, and is filled about two-thirds full when in use, is fitted with shoulder straps (inelastic suspender straps) and a piece barely large enough to admit the hose of the Hydronette is cut out from the end of the tank cover at the edge (*e*) and a short collar soldered into it with a slot on its outer side broad enough to allow the hose to be pushed into it sideways. The hose, after it is pushed in, should project through this slot just enough to be held firmly against the edge of the tank when the tightly fitting cover is shut down. The suction basket of the pump (*f*) therefore rests in the lower left hand corner of the tank, and by making the shoulder strap on this side slightly looser than the other, and thus tipping the tank a little towards this point, all the contained liquid will be drawn out.



Since pumps of the Hydronette pattern do not throw a steady stream, acting only when the piston is driven back, some appliance is necessary to produce an even, continuous spray. This is gained by the device represented in the figure. A piece, six inches long, of *heavy* §-inch rubber *tubing* (hose will not answer,

neither will old bits of tubing which have been lying about in a rubber store till their elasticity is impaired) is drawn over the end of the Hydronette nozzle at x and over the base of the Vermorel nozzle at x' (the large coupling which accompanies this nozzle having been previously screwed off and laid aside) and each end x, and x', is then firmly wound with small copper wire so that the joints are firm and tight. The Hydronette nozzle and the Vermorel are thus connected by an elastic chamber formed by the tubing; but since the latter is liable to burst if too great force is used in pumping, it is necessary to inclose the tubing in a cloth cylinder which acts to prevent undue expansion, like the netting commonly used about elastic syringe bulbs. Take a piece of stout cotton cloth, 6½ inches each way, and sew two of the edges together strongly, so as to make a cylinder 5½ inches in circumference. This allows sufficient expansion to the tubing without danger of its bursting. Slip this cylinder of cloth (g) over the tubing and fasten each end securely by winding it tightly with small copper wire. Then connect the two nozzles (a) and (d) by two heavy copper wires (c), fastened by winding once or twice around each nozzle. The Vermorel nozzle is thus held firmly in place, and as the large wires will stand any amount of bending, the direction of the stream is thus easily regulated. The size of the elastic chamber, and consequently the duration of the spray from a single stroke of the pump, may be increased by using a greater length of tubing and connecting the two nozzles by correspondingly longer wires; but it will not be found convenient to use a size of tubing larger than ⅝-inch or to use a shorter length than 6 inches. In order to reach a greater distance with the spray, a few feet of light brass tubing may be soldered on to a coupling which may be screwed on in place of the Hydronette nozzle, and to the end of this tubing the Vermorel nozzle may be adjusted as just described.

The advantage of this apparatus is that in addition to its cheapness (its total cost is a little over $8.00), it leaves the force pump free, when not wanted for spraying, for any of the numerous uses to which such a pump is ordinarily put, and is also readily made by any one of ordinary intelligence. To make it work successfully, however, several things are necessary. First, the pump must be in good order; properly packed, and the screw (h) which bears upon the packing must be loose enough to allow of an easy movement of the piston, which should be well oiled.

If the rubber tubing is not old and inelastic, and is properly adjusted, as described, no trouble will be found with the working of the apparatus. By alternating the motion, holding the right hand stationary and working with the left and *vice versa*, the operation is not at all laborious. If the pump is in good condition at the outset, it will not get out of order either from clogging or other causes, and very quick work can be done with it by enlarging the hole in the Vermorel cap as previously described. The writer uses this pump in preference to the Eureka sprayer owned by the Station, to which it is superior in several points, and is confident that it will give satisfaction when properly constructed.

Fungicides.—The Bordeaux mixture for general purposes can be recommended as more effectual than any of the somewhat numerous preparations which have been used as fungicides, although it seems probable that a cheaper and almost, if not quite, as effective a material will be found in some of the formulæ for precipitated carbonate of copper. Another year, however, is needed to test these thoroughly before they can be definitely recommended in place of the Bordeaux mixture. The ammoniacal carbonate of copper is decidedly inferior to the Bordeaux mixture; but is very useful for the last two sprayings in cases where there is danger of any considerable amount of the Bordeaux mixture adhering to fruit, grapes for example, when they are ready to gather.

Strong solutions of sulphate of copper or of sulphate of iron are also often useful for what is known as the winter treatment, which is very valuable, for instance, against the Anthracnose of the vine.

These three fungicides, the Bordeaux mixture for general purposes, and the others as above indicated, had best be employed by persons using fungicides for the first time, without regard to other formulæ which they may see advertised or recommended. The method of preparing them is as follows:

Bordeaux Mixture.

Sulphate of Copper (blue stone)	6 lbs.
Quicklime	4 lbs.
Water	22 gals.

Dissolve the sulphate of copper in two gallons of water, hot, to hasten its solution, which is also facilitated if the sulphate is pulverized. When all the sulphate is dissolved, dilute this solution

with fourteen gallons of water. Slake the lime, which must be fresh (i. e., not partly air-slaked), with six gallons of water, adding the latter slowly and stirring the mixture to a smooth paste. Allow this mixture to stand a short time, then stir it and pour it slowly into the sulphate solution, which should be rapidly stirred during the operation. Only use that portion of the lime which is held readily in suspension by stirring slightly. *Never pour in any of the coarser sediment, which settles readily to the bottom.* By using care in this respect the Bordeaux mixture will need no straining if the vessels and water are clean; that is, free from straws, chips, etc., but must otherwise be strained through fine brass gauze.

Carbonate of Copper.—This substance can be bought ready made at from 60 to 75 cents a pound; but can be made without great trouble at about 15 cents or less. Enough for a season's use had best be made at once, as follows. The substances needed for this purpose are sulphate of copper and carbonate of soda (sal soda) in the proportion of four parts of the copper to five parts of the soda. For instance, to make one pound of carbonate of copper it is necessary to use two pounds of sulphate of copper and two and a half pounds of sal soda.

The sal soda should be dissolved in hot water in one barrel, and the sulphate of copper in another. When both are wholly dissolved and *cooled* pour the sal soda solution slowly into the copper solution, stirring during the operation, which yields a heavy green precipitate of carbonate of copper. Since the sal soda is in excess and is injurious to foliage, it has to be washed out of the carbonate of copper. To do this fill the barrel up with water and stir it thoroughly. Then allow the carbonate to settle to the bottom of the barrel, and then siphon off the clear water which stands above it. Repeat this operation once. The carbonate of copper must then be strained out on a piece of porous cloth which can be tacked over a barrel so as to form a shallow bag into which the mixture of carbonate of copper and water can be poured and allowed to drain, after which it can be dried. No difficulty will be found in the process, and as it saves several hundred per cent. on the cost of material it is quite worth while.

At the suggestion of Prof. Johnson the carbonate of ammonia was tried as a solvent for the carbonate of copper and a lot of the solution made up in the laboratory, but not used for spray-

ing. Prof. Chester, however, of the Delaware Station, has used the same solvent in spraying during the past season, and recommends it as much better than ammonia for the purpose. Its trial, therefore, in preference to the ammoniacal solution, the formula for which is given below, may be safely recommended, as it is more than twice as cheap and easily prepared as follows, the formula being that used by Prof. Chester:

Mix three ounces of carbonate of copper and one pound of pulverized carbonate of ammonia; add two quarts of hot water, obtaining a clear solution. Dilute for use with water to fifty gallons.

Ammoniacal Carbonate of Copper.

Dissolve three ounces of carbonate of copper in one quart of strong ammonia (22°). Dilute for use with 25 gallons of water. Add the ammonia to the carbonate in a jar or bottle.

Since the prices of manufacturers and dealers in materials and apparatus necessary for spraying are very variable, special attention is called to the following quotations which are the lowest which the Station has been able to procure.

Quotations for spraying pumps and accessories given by W. & B. Douglas for goods ordered directly from their factories at Middletown, Conn. (These prices are *net.*)

Double Acting Spraying Pump (similar to Gould's) with all brass piston and brass outer cylinder	$9.50
——Double Acting Spraying Pump (similar to Gould's) with all brass piston and iron outer cylinder, fitted with leather valves	5.00
——The same, fitted with metallic valves	6.50
Three feet suction hose for same with couplings and brass strainer	2.25
Single couplings for ¼-inch hose	.25
Y-couplings " "	1.00
"Aquanette" force pump	4.00
Vermorel Nozzle (2 caps with coupling for ¼-inch hose or with large standard coupling as desired)	1.25
The Messrs. Douglas will also be prepared to furnish Prof. Galloway's Knapsack Spraying Pump previously mentioned or it can be obtained from Albinson & Co., 2026 14th St., or Leitch & Sons, 1214 D St., Washington, D. C., for about	11.00
Tanks arranged for use with Hydronette or Aquanette as shown in cut on page 108 can be made of unplanished copper with tin cover by any tinman for less than	3.00

Quotations for tubing given by the Goodyear Rubber Store, F. C. Tuttle, prop., 866 Chapel St., New Haven.

¼-inch linen insertion tubing (lots of 100 feet or more) per foot	.08
" " " " (lots of 50 feet or more) per foot	.10
" " " " (lots of less than 50 feet) per foot	.12
¼-inch heavy rubber tubing, per foot	·20

Quotations for sulphate of copper given by The Nichols Chemical Co., 68 William St., N. Y.

For lots of 25 to 50 pounds f. o. b., New York, 5 cents per pound.

NOTE. BY THE DIRECTOR.

An *Ammonia-Copper Solution*, cheap and easy of preparation is perhaps best made as follows :—Provide—

½ pound of sulphate of copper (blue vitriol) pulverized.

1 " " hard and transparent* carb. of ammonia pulverized.

6 quarts of boiling water.

The substances may be easily reduced to coarse powder without loss by pounding with a mallet or stick of wood on a stout sheet of paper or in a small box.

Bring the carbonate of ammonia and hot water together in a wooden pail and stir until foaming ceases, then add the copper sulphate and stir again as long as the mixture effervesces. The blue and nearly clear liquid diluted to 62 gallons (2 barrels) will correspond to Prof. Chester's formula, or diluted to 31 gallons will be nearly equivalent, to the "Ammoniacal Carbonate of Copper" of the preceding page.

The solutions thus obtained differ somewhat in composition from those described on page 112. As regards copper content they are alike and the fungicide efficacy of the ammonia-copper compound is most probably the same in them all, but the last described solutions contain 4¼ oz. of sulphate of ammonia in the barrel or two barrels respectively, which is in the ratio of 1 to 970 or 1940 of liquid. This small proportion of sulphate of ammonia it may be anticipated will have no injurious effect on foliage. These solutions probably contain less free ammonia or carbonate of ammonia than those noticed on page 112 and in this respect are accordingly safer applications.

This method of preparing *Ammonia-Copper Solution* will, it is hoped, render the purchase or making of carbonate of copper and the use of liquid ammonia unnecessary. Practical trials are of course requisite to establish its usefulness and to prove what dilutions are the most proper.

*If, by long keeping, the carbonate of ammonia has become soft and opake a larger amount up to 1½ lbs. will be needful.

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THE PROTEIDS OR ALBUMINOIDS OF THE OAT-KERNEL.*

By THOMAS B. OSBORNE, Ph.D.

I. Historical.

The Proteids contained in or derived from the oat-grain have been specially studied by J. P. Norton, Baron von Bibra and Dr. W. Kreusler. Norton† recognized three proteids, viz: 1. *Albumin*, 0.5 to 2.17 p. c., which was taken up from the "epidermis," (after starch had been mechanically removed by elutriation with slightly ammoniacal water), by boiling with acetic acid and was precipitated by neutralizing the solution. 2d. *Casein* (or *avenine*, as Johnston, in whose laboratory the work was done, named it), 15.76 to 17.72 p. c., which was dissolved in the slightly ammoniacal water used in separating starch, and thrown down by acetic acid. 3. *Glutin*, 1.33 to 2.47 p. c., extracted by alcohol and separated from oil by means of ether, and from sugar by water.

Von Bibra‡ found that no coherent gluten could be got from oat-flour by kneading in water. He recognized *Albumin*, 1.24 to 1.52 p. c., precipitated by boiling the cold-water-extract of the ground oats; *Casein*, 0.15 to 0.17 p. c., the body separating from the hot alcohol-extract on cooling; *Plant-gelatin* (Dumas' *glutin*, Taddei's *gliadin*), 3.00 to 3.25 p. c., the substance soluble both in hot and cold alcohol; and *Nitrogenous substance insoluble in water and alcohol*, 11.38 to 14.85 p. c.

Kreusler§ found *Oat-Gliadin* soluble in weak alcohol and *Oat-Legumin* soluble in very dilute alkali.

Since the date of Kreusler's work, 1869, our knowledge of proteid bodies and of the methods for their investigation has been considerably extended. This advance has been chiefly in the study of the animal proteids, but little real progress having been made in our knowledge of the vegetable albuminoids. The following research was undertaken with a view to applying the newer methods of study to the plant-proteids that have agricultural importance.

*An abstract of this Paper was read by the Author before the National Academy of Sciences, in Boston. November 13th, 1890.

† Am. Jour. of Sci. and Arts, 2d ser., iii, 330, (1845), and v, 22, (1848).

‡ Die Getreidearten und das Brod. Nürnberg, (1860).

§ Jour. für Pr. Chemie, cvii, 17, (1869).

II. Oat-Proteids extracted by Weak Alcohol.

Kreusler's Work.

The Oat-proteid soluble in weak alcohol was first examined and, as results differing from Kreusler's were obtained, it will be well to give here a brief summary of his work.

Kreusler found that, on extracting ground oats with alcohol of 80 p. c. and concentrating the extract to one-third of its volume, a considerable amount of substance separated which, after subsiding from the solution, became a tough, transparent mass of amber-yellow color. The solution decanted from this substance and further concentrated, yielded a second deposit. The liquid poured from this second deposit yielded, on still further concentration, a third. The three sediments were united and dissolved in 80 p. c. alcohol at a gentle heat. On cooling, the greater part of the substance precipitated. After decanting the liquid, this precipitate was treated with absolute alcohol, which caused it to gather on the walls of the vessel as a tenacious mass. After treating with ether and again with absolute alcohol, it was dried over sulphuric acid. This Kreusler designated A.

By concentrating the solution decanted from A, on cooling, he obtained a second precipitate B. The filtrate from B by similar treatment yielded a third precipitate C.

These three precipitates showed the same behavior with various reagents and appeared to differ only in their degree of purity. The reactions agreed with those of gliadin from wheat which, according to Ritthausen, contains 18 p. c. of nitrogen.

Kreusler found that :

A contained 16.22 per cent. of nitrogen.
B " 16.21 " " "
C " 15.36 " " "

These three preparations were united, dissolved in dilute acetic acid and fractionally precipitated by dilute potash. Thus were obtained three precipitates:

I with 16.00 per cent. of nitrogen.
II " 16.51 " " "
III was too small in amount for analysis.

By this treatment the substance was separated into two portions of different nitrogen-content.

Kreusler in the next place prepared a new extract with alcohol of 80 p. c. from five pounds of ground oats, concentrated the solu-

tion until nearly all the alcohol was removed, and on cooling and treating the precipitate with ether and absolute alcohol and drying over sulphuric acid, obtained thirty grams of substance having properties like the former preparations, but not wholly soluble in acetic acid. This precipitate contained 15.36 p. c. of nitrogen. When it was heated with acetic acid, a residue was left, having 14.81 p. c. of nitrogen. The acetic acid solution, by three partial precipitations with dilute potash, gave, as before, precipitates I, II and III—the third being too little for analysis. The composition was:

	I.	II.
Carbon.....	....	53.41
Hydrogen ...	....	7.15
Nitrogen	16.99	17.14

This treatment, however, had failed to yield a product having as much nitrogen as Ritthausen's gliadin.

I and II were, therefore, united and dissolved in 60 p. c. alcohol at a gentle heat. The solution was brownish yellow, and on cooling, a part of the substance precipitated. The filtrate from this precipitate gave a second precipitate when treated with absolute alcohol. These precipitates were united and called A. The alcoholic filtrate contained a considerable amount of substance which was separated by concentration and gradual precipitation with absolute alcohol. This precipitate was marked B and resembled A in appearance. They contained:

	A.	B.
Carbon.....	....	52.64
Hydrogen ...	....	7.66
Nitrogen	17.71	16.70

Since the substance was precipitated in the presence of a considerable amount of acetic acid and might be thought to retain some of the latter, the just-described process was repeated with A and potash added to perfect neutralization. The precipitate thus obtained was slightly washed with water, and after dissolving in 60 p. c. alcohol was precipitated with absolute alcohol. B was dissolved directly in weak alcohol, and precipitated by absolute. These products then had the following composition:

	A.	B.
Carbon	52.94	53.12
Hydrogen.....	7.71	8.15
Nitrogen	17.28 17.30	17.20

These preparations were next united and dissolved by heating in 60 p. c. alcohol; a varnish-like mass deposited on cooling. This process was repeated several times, and the substance was finally dried with absolute alcohol. It had the following composition as found in analyses I and II.

			Gliadin.	
			Oats.	Wheat.
	I.	II.	Kreusler.	Ritthausen.
Carbon	52.94	52.59	52.59	52.60
Hydrogen	7.58	7.65	7.65	7.00
Nitrogen	17.71	----	17.71	18.06
Sulphur	1.71	1.61	1.66	.85
Oxygen	20.06		20.39	21.49
	100.00		100.00	100.00

The alcoholic solution after concentrating gave on cooling a preparation with 17.2 per cent nitrogen. Kreusler rejected the highest carbon-determination (obtained without the use of lead-dioxide) as probably erroneous, and wrote his analysis of *oat-gliadin* beside Ritthausen's analysis of *wheat-gliadin*, as quoted above. Kreusler concludes that oat-gliadin is essentially different from wheat-gliadin and compares at length the behavior of the two towards reagents. The one point of difference he mentions is that the oat-gliadin dissolves in concentrated hydrochloric acid to a scarcely colored liquid, while wheat-gliadin gives a blue solution.

It is evident from Kreusler's paper that he expected to find the alcohol-soluble proteid of oats to have the same composition as wheat-gliadin. He finally accepted, as pure, a preparation having 17.71 per cent. of nitrogen, according to a single determination.

It is to be noticed on reviewing his analyses that the treatment to which Kreusler submitted his preparations, while on the whole tending to raise the nitrogen-content, sometimes appears to have had the opposite effect and the conclusion is not improbable that the fluctuations in the per cent. of nitrogen found by him are partly attributable to the then unknown errors involved in the soda-lime method of analysis—errors which Ritthausen* and U. Kreusler† in later years fully appreciated and made the subject of special investigation.

* Pflüger's Archiv., xviii, 236, (1878).

† Landw. Vs-St. xxiv, 37, (1880), und ibid, xxxi, 248, (1885).

III. Oat-Proteids extracted by Weak Alcohol.

The Writer's Work.

1. *Direct Extraction with Alcohol.* Preparations **1–8.**

As Ritthausen had separated the gliadin, mucedin and fibrin found by him in wheat gluten, from alcohol-solution by fractional precipitations, the writer judged that if more than one proteid were extracted from oats by alcohol, this fact would be shown by differences in behavior and composition of various fractions of the alcoholic extract. Accordingly four kilos. of freshly-ground oats were heated on the water bath with ten liters of alcohol, of ·915 sp. gr. After boiling for half an hour the extract was strained through cloth, the residue pressed out and the extraction repeated. The extracts were united, allowed to stand over night, decanted from sediment, and filtered clear. This solution was concentrated to one-third by distillation. After standing for twenty hours at room-temperatures, the residue deposited a bulky yellowish precipitate. About four-fifths of the solution was carefully decanted from this precipitate. The remaining one-fifth could not be filtered until a large amount of strong alcohol had been added, which caused the precipitate to separate. After filtering, the precipitate was treated with absolute alcohol, next with ether, and after removing the ether, with absolute alcohol again, and dried over sulphuric acid. This preparation, **1**, then weighed 15·5 gm. and, dried at 110° C., contained 13.92 per cent. of nitrogen. The liquid decanted from **1**, was still further concentrated to about one-third of *its* volume and cooled. The precipitate which formed, **2**, was treated with absolute alcohol and ether and, after drying over sulphuric acid, weighed 10.30 grams. Dried at 110° C., it contained 12.36 per cent. of nitrogen. The filtrate from **2** was concentrated to a thick syrup. On cooling a deposit formed on the bottom of the dish. The syrup was poured off and this deposit treated successively with strong alcohol, absolute alcohol, ether, and finally with absolute alcohol again. After drying over sulphuric acid, this precipitate, **3**, weighed 6.82 grams, and contained, when dried at 110° C., 10.37 per cent. of nitrogen.

The alcoholic liquids obtained by washing preparations **1**, **2**, and **3**, were found to have dissolved a large amount of proteid, they were therefore united and concentrated on the water-bath to small volume and cooled. The abundant deposit was washed with

absolute alcohol, ether, absolute alcohol again, and dried over sulphuric acid. The 14.62 grams thus obtained, **4**, when dried at 110° C., contained 16.27 per cent. of nitrogen. The filtrate from **4** was still further concentrated, and after cooling and adding a large amount of alcohol gave a precipitate, **5**, which when treated as the others, weighed 4.21 grams and contained 6.0 per cent. of nitrogen. The filtrate from **5** was highly concentrated and treated with absolute alcohol. The precipitate thus thrown down, **6**, after treating with absolute alcohol, ether, absolute alcohol again, and drying over sulphuric acid, weighed 17.78 grams and contained 8.61 per cent. of nitrogen.

To sum up: From the alcoholic extract by concentrating and cooling three times there resulted three preparations, viz :

1, of 15.5 grams, containing 13.92 per cent. of nitrogen.
2, of 10.30 " " 12.36 " "
3, of 6.82 " " 10.37 " "

From the alcoholic washings of **1, 2** and **3** by concentration and cooling was obtained preparation

4, of 14.62 grams containing 16.27 per cent. of nitrogen.

And by further concentration and addition of much strong alcohol,

5, of 4.21 grams containing 6.00 per cent. of nitrogen.
6, of 17.78 " " 8.61 " "

The principal impurity recognized in these preparations was sugar, which was abundant in **5** and **6**.

These six preparations were examined separately.

1 was warmed with alcohol of 75 per cent., but was only partly soluble, and owing to its slimy nature could not be filtered. Three volumes of strong alcohol were added, making the solvent equivalent to 2 liters of about 88 per cent. alcohol. After heating to boiling and cooling, a little substance separated, which was filtered out, together with the undissolved portion. This precipitate and residue, **1. A.**, after treatment with absolute alcohol, ether, etc., as before described, weighed 3.68 grams and contained 14.57 per cent. of nitrogen.

The filtrate from **1. A.** concentrated to one-third and cooled, deposited but little substance. Addition of an equal volume of water produced a precipitate. The liquid was poured off and the deposit treated with a large amount of absolute alcohol. The

residue, **1. B.**, after drying weighed 3.05 grams, and contained 15.39 per cent. of nitrogen. Water was added to the filtrate from **1. B.**—but only a trifling precipitate resulted. The aqueous solution was then boiled, the coagulum filtered off, washed with absolute alcohol and dried over sulphuric acid. This preparation, **1. C.**, weighed 2.45 grams and contained as follows:

COAGULATED PROTEID.—*Directly extracted from Ground Oats by Weak Alcohol.*

	1. C.
Carbon	52.66
Hydrogen	6.89
Nitrogen	16.32
Sulphur, Oxygen, Ash	24.13
	100 00

Carbon and Hydrogen.—.3120 gram dried at 110° C. gave .6025 gram CO_2 = 52.66 per cent. C, and .1934 gram H_2O = 6.89 p. c. H.

Nitrogen, by Kjeldahl method.—.5624 gram dried at 110° C. gave ammonia = 10.75 cc. HCl (1 c. c. HCl = .00854 gram N) = 16.32 p. c.

Ash could not be determined for want of material.

Nothing more could be obtained out of the filtrate from **1. C.** **2.** and **3.** were united and treated with 400 c. c. of boiling alcohol of 0.9 sp. gr. A part dissolved to a deep-red solution. The residue was extracted again with hot dilute alcohol and treated in the same manner as the other preparations. Thus was obtained 9·05 grams of substance **2** and **3. A.** containing 15·47 per cent. of nitrogen.

This preparation was again treated first with hot water and then with hot alcohol of 0.9 sp. gr., but only a little dissolved and the nitrogen-content was unchanged.

The alcoholic filtrate from **2** and **3. A.** was further examined, but only 2.3 grams of substance with 7.66 per cent. of nitrogen were obtained. The long heating in very weak alcohol to which preparations **2** and **3** had been subjected, had rendered a large share of the proteid insoluble, and it was therefore lost for further purification.

4 was treated with 500 c. c. of alcohol of 0.9 sp. gr., in which a part was insoluble, **4. A.** This was washed with alcohol and ether, dehydrated with absolute alcohol and after drying over sulphuric acid weighed 8.9 grams. Its analysis follows:

COAGULATED PROTEID.—*Directly extracted from Ground Oats by Weak Alcohol.*

4. A.

Carbon	53.09
Hydrogen	6.96
Nitrogen	16.56
Sulphur, Oxygen	23.39
	100.00
Ash	.35

Ash.—.5069 gram air-dried = .4555 dried at 110° C. gave .0016 gram ash = .35 p. c.

Carbon and Hydrogen.—.4354 gram dried at 110° C. gave .8445 gram CO_2 = 52.90 p. c. C, and .2716 gram H_2O = 6.91 p. c. H.

Nitrogen by Dumas' Method.—.5425 gram dried at 110° C. gave 76.12 c.c. gas at 9°C. Barometer 756 .3^{mm} at 9° C.= 16.76 p. c. less correction of .20 = 16.56 per cent. N.

The alcoholic filtrate from **4. A.** was concentrated to small volume, but as a slimy precipitate appeared, which could not be filtered, the solution was mixed with water. This did not cause the substance to separate in a manageable form, so the liquid was boiled, and after cooling the substance deposited as a gelatinous lump. After filtering, the deposit, **4 B.**, was treated with absolute alcohol and with ether and dried over sulphuric acid. It weighed 2.6 grams. Its analysis is subjoined :

COAGULATED PROTEID.—*Directly extracted from Ground Oats by Weak Alcohol.*

4. B.

	I.	II.
Carbon	53.12	....
Hydrogen	6.91	....
Nitrogen	16.52	16.39
Sulphur, Oxygen, Ash	23.45	....
	100.00	

Ash.—Very little. Not determined for want of substance.

Carbon and Hydrogen.—.3445 gram dried at 110° C. gave .6700 gram CO_2 = 53.12 p. c. C and .2143 gram H_2O = 6.91 p. c. H.

Nitrogen.—I. By Dumas' method—.2693 gram dried at 110° C. gave 37.93 c. c. gas at 8° C. less correction of .7 c. c. Barometer 756.3 mm. at 9° C.=16.52 p. c. N.

Nitrogen.—II. By Kjeldahl method—.2693 gram substance dried at 110° C. gave ammonia = 9.68 cc. HCl (1 cc. HCl = .00854 gram N) = 16.39 p. c.

The filtrate from **4. B.** was evaporated to dryness and yielded one gram of substance containing 7.5 per cent. of nitrogen.

6. evidently contained a large amount of sugar. It was first treated repeatedly with water, in which it formed a pasty lump. This was dehydrated with absolute alcohol, and when dried over sulphuric acid weighed 7.63 gm. and contained 14.61 per cent. of nitrogen. **6. A.**

6. A. was then treated with 100 c. c. of water, with which it formed a stringy lump which, after thoroughly kneading under water, assumed a semi-liquid condition and could not be separated from the solution either by boiling or freezing. The solution after concentrating on the water-bath to about 30 c. c. was poured into 300 c. c. of absolute alcohol. This threw down a curdy white precipitate which, after treating with absolute alcohol and drying over sulphuric acid, weighed 6 gm. and contained 15.67 per cent. of nitrogen when dried at 110° C. **6. A. 1.**

6. A. 1. was treated with 500 c. c. of alcohol of 0.9 sp. gr. But little dissolved and the solution was too slimy to filter. The whole was then concentrated to one-third and cooled, but no separation took place which would allow of filtering or decanting the solution. The solution was, therefore, diluted with water and boiled. After cooling, a curdy precipitate settled out, leaving a turbid liquid. This liquid was decanted and poured into a large amount of absolute alcohol. On standing a precipitate separated which, when treated with absolute alcohol and dried over sulphuric acid, weighed .455 gm. and contained, when dried at 110° C., 16.40 per cent. of nitrogen. **6. A. 2.**

There was thus obtained of the proteid soluble in alcohol a large number of fractional precipitations with different nitrogen-content. It will be noticed, however, that five of these preparations have from 16.27 to 16.56 per cent. of nitrogen. No preparations were obtained having a higher percentage of nitrogen, and none of the other preparations approximate to a constant nitrogen-content.

4. had 16.27 per cent. of nitrogen. When this was separated into two parts, one soluble in dilute alcohol, **4. B.** and the other

insoluble, **4. A.**, the two parts were found to contain the same proportion of nitrogen, and agreed together exactly in content of carbon and hydrogen. This is what might be expected of a pure proteid, for some of these bodies become insoluble without change of composition, so far as can be detected by our methods of analysis. **1. C.** without correction for ash, has nearly the same composition as **4. A.** and **4. B.** a correction would tend to bring it into closer agreement; the amount of substance however, was insufficient for an ash-determination.

As all the preparations analyzed thus far, were the insoluble modification of the proteid, a new extract was prepared. Five pounds of freshly-ground oats were boiled up with 10 liters of alcohol of 0.915 sp. gr. The extract was pressed out, and added to another five pounds of oats and again heated to boiling. After filtering, a perfectly clear, deep ruby-red solution was obtained. This was concentrated by distillation on the water-bath to about one-third of its original volume. On cooling, a large amount of substance separated. This was thrown upon a filter and, after 24 hours, about seven-eighths of the solution passed through. The filter, with its contents, was then returned to the flask and boiled in 10 liters of 60 per cent. alcohol, with a reflux condenser, for four hours. The substance entirely dissolved to a clear, deep red solution. The solution was then concentrated by distillation to about one-half and cooled rapidly to 35° C., when it filtered readily. The precipitate formed a tough, jelly-like mass which did not adhere to the paper. It was boiled, as before, for several hours, with 10 liters of 60 per cent. alcohol until dissolved completely. The perfectly clear solution was concentrated to one-half its volume, during which operation a large part of the substance deposited on the interior of the flask as a thick, leather-like coating. This coating readily separated from the glass in large pieces of a dark-brown color. On cooling the liquid, a finely-divided yellowish precipitate appeared which did not settle out on standing. The muddy liquid was poured off and the leathery deposit was minced and treated with absolute alcohol in order, if possible, to dehydrate the substance and render it pulverizable for analysis, but as it remained 48 hours without change the attempt was abandoned. The substance suspended in the muddy liquid was now caused to separate by adding alcohol After filtering, washing first with strong, then with absolute alcohol, the precipitate was united to the portion which had been digested with absolute alcohol and

the whole was boiled in two liters of 60 per cent. alcohol with return condenser. After three hours' boiling, about one-half had dissolved. Two liters more of 60 per cent. alcohol were then added and the boiling continued. Considerable proteid still remained in a gelatinous form on the sides of the flask. The solution was filtered off and 1200 c. c. of absolute alcohol were poured on the residual substance. This caused the jelly to break up into coarse lumps, whereupon 800 c. c. of water were added, making two liters of 60 per cent. alcohol, and the boiling on the water-bath was continued for several hours. Some of the substance dissolved, the liquid was filtered, and the insoluble residue was treated for many days with absolute alcohol. It was then ground to a fine powder while still moist with alcohol, extracted with ether, and dried over sulphuric acid. This preparation, **7.**, weighed 9.1 grams.

The alcoholic solution filtered from the insoluble portion was concentrated to one-half and filtered while hot from the large amount of substance which had separated. The latter resembled raw rubber in appearance and consistence but not in elasticity. It was finely minced, and after digesting with absolute alcohol was pulverized, treated again with absolute alcohol, washed with ether, and dried over sulphuric acid. This, **8.**, weighed 26 grams, and was a light powder of yellowish color. Unlike all the other preparations extracted from the oats by weak alcohol, which were analyzed, 8 was still largely "uncoagulated" and soluble in that solvent.

These two preparations were analyzed with the following results:

COAGULATED PROTEID.—*Directly extracted from Ground Oats by Weak Alcohol.*

	7.			
	I.	II.	III.	I. Ash-free.
Carbon	52.98	----	----	53.10
Hydrogen	6.86	----	----	6.87
Nitrogen	16.34	16.41	16.39	16.39
Sulphur, Oxygen	----	----	---	23.64
Ash	.25	----	----	----
				100.00

Ash.—1.007 gm. air-dried substance =.9291 gm., dried at 110° C. gave .0023 gm. Ash = .25 p. c.

Carbon and Hydrogen.—.5076 gm. dried at 110° C., gave .9860 gm. CO_2 = 52.98 p. c. C, and .3131 gm. H_2O = 6.86 p. c. H.

Nitrogen, I. Dumas' Method—.5000 gm. air-dried = 4606 gm. dried at 110° C. gave 64.1 cc. gas at 8° C. Barometer 750 mm., at 15° C. = 16.54 p. c. less .20 found in blank = 16.34 p. c. N.

Nitrogen, II. Kjeldahl Method—.5000 gm. air-dried = .4606 gm. dried at 110° C., gave ammonia = 8.85 cc. HCl (1 cc. HCl = .00854 N) = 16.41 p. c.

III.— .5000 gm., air-dried = .4611 gm., dried at 110° C., gave ammonia = 8.85 cc. HCl = 16.39 p. c. N.

SOLUBLE PROTEID.—*Directly extracted from Ground Oats by Weak Alcohol.*

	I.	II.	8. III.	IV.	I. Ash-free.
Carbon	52.92	----	----	----	53.06
Hydrogen	6.93	----	----	----	6.94
Nitrogen	16.33	16.33	16.45	16.54	16.38
Sulphur	2.25	2.21	----	----	2.26
Oxygen	----	----	----	----	21.36
Ash	.24	----	----	----	----
					100.00

Ash.—1.0045 gm. air-dried, equal to .9027 gm. dried at 110° C., gave .0022 gm. ash = .24 p. c.

Carbon and Hydrogen.—.4821 gm. dried at 110° C., gave .9356 gm. CO_2 = 52.92 p. c. C., and .3003 gm. H_2O = 6.93 p. c. H.

Nitrogen, I.—Dumas' Method.—.5000 gm. air-dried = .4554 gm., dried at 110° C., gave 63.1 cc., gas at 10° C. Barometer 759.5 mm. at 16° C. = 16.53 p. c., less correction .20 = 16.33 p. c. N.

II.—.5000 gm. = .4490 gm., dried at 110° C., gave 62.42 cc. gas at 14° C. Barometer 770.3 mm., at 17° C. = 16.53 p. c. Corrected = 16.33 p. c. N.

III.—Kjeldahl Method.—.5000 gm. = .4490 gm., dried at 110° C., gave ammonia = 8.65 cc. HCl (1 cc. HCl = .00854 gm. N) = 16.45 p. c. N.

IV.—.5000 gm. = .4490 gm., dried at 110° C., gave ammonia = 8.70 cc. HCl = 16.54 p. c. N.

Sulphur, I.—1. gm., air-dried = .9107 gm., dried at 110° C., gave .1850 gm. $BaSO_4$, which when fused with Na_2CO_3 and reprecipitated, gave .1495 gm. $BaSO_4$ = .20532 gm. Sulphur = 2.25 p. c.

II.—1. gm. = .9107 gm., dried at 110° C., gave .1575 gm. $BaSO_4$, which, when fused with Na_2CO_3, and reprecipitated, gave .1469 gm. $BaSO_4$ = .20175 gm. Sulphur = 2.21 p. c.

These analyses are observed to agree closely with each other, as well as with several of the preparations obtained under various conditions from the first extract already described, as is shown by the following table.

OAT-PROTEID EXTRACTED BY WEAK ALCOHOL.

	Soluble.	Coagulated					
	8	7	1C*	4A.	4B.*	4	6A.2*
Carbon	53.06	53.10	52.66	53.09	53.12	----	----
Hydrogen	6.94	6.87	6.89	6.96	6.91	----	----
Nitrogen	16.38	16.39	16.32	16.56	16.52	16.27	16.40
Sulphur	2.26	23.64	24.13	23.39	23.45	----	---
Oxygen	21.36					----	----
	100.00	100.00	100.00	100.00	100.00		

* Not corrected for ash.

The figures given by Kreusler for the nitrogen of two precipitates from his first alcoholic extract are likewise in close agreement with the above, viz :—16.22 and 16.21 p. c. From his "oat-legumin" Kreusler also extracted by means of alcohol a substance with 16.38 p. c. nitrogen.

It seems hardly probable that such concordant analyses could result from impure preparations or from a mixture of two or more proteids, especially in view of the varying conditions under which the preparations were obtained.

The very high content of sulphur is remarkable. No other analysis of a vegetable proteid approaches this amount. Ritthausen (Pflüger's Archiv., Bd. xxi, p. 95, 1880), found indeed in a single preparation from sesame press-cake, 2.36 p. c., but he attributed this high percentage to some foreign substance precipitated with the proteid. He afterwards (Jour. f. Pr. Chem., 1882, Bd. xxvi, p. 444), stated the percentage of sulphur as 1.25, and ascribed the high figure first obtained to calcium sulphate. Among the animal-proteids besides *Keratin*, some forms of human *serum-albumin* contain 2.3 p. c. of sulphur.*

The fact that sulphur in my analyses is .60 p. c. more than found by Kreusler in his gliadin, indicates that his substance had undergone chemical change during the processes of preparation.

Ritthausen believes to have obtained from wheat-gluten by extracting with alcohol, three distinct proteids, to which he applies the names fibrin, gliadin and mucedin, and he includes under one or the other of these terms all the alcohol-soluble proteids which he and Kreusler found in their extended study of the cereals. That portion of wheat-gluten which is insoluble in alcohol Ritthausen denominated *gluten-casein.*

On the authority of Ritthausen, his names and the composition attributed by him to these substances, have passed into chemical literature and have superseded the mostly different designations and analyses of the older investigators.

The alcohol-soluble proteid of the oat which I have obtained, differs, however, essentially in composition from all these preparations of Ritthausen and Kreusler. Kreusler's analysis of mucedin from barley-grits alone fairly agrees with my results, as respects carbon, hydrogen and nitrogen, but the same chemist's analysis of mucedin from barley-meal gives .84 p. c. higher nitrogen than that from grits and but .68 p. c. sulphur.

* Starke. Jahresbericht der Thier-Chemie, xi, p. 19 (1881).

In case of the other substances the discrepancies are still more decided. The properties and reactions given by Kreusler for the substance called by him oat-gliadin are true of the body just described, but these reactions mostly belong to proteids in general, or to the mucedin and fibrin of Ritthausen, and are not characteristic of any one body. Ritthausen states that on evaporating the alcohol-solution of the gluten-fibrin prepared by him from wheat-gluten, a pellicle forms on the surface which renews itself as often as removed, and that neither mucedin nor gliadin show this property. I have frequently observed the formation of films on evaporating solutions of the alcohol-soluble proteid from oats. This body, however, can not be a mixture of Ritthausen's fibrin and gliadin as its sulphur-content so largely exceeds theirs.

2. *Extraction with Alcohol after treatment with Water.* Preparation 9.

Five pounds of oats were treated with water as long as any proteid was dissolved. The residue was then twice extracted with alcohol and strongly pressed. The first alcoholic extract was evaporated so far as to remove nearly all the alcohol. On cooling, the solution became turbid and after standing deposited a brown slimy substance exceedingly soluble in dilute alcohol. The liquid was decanted and the precipitate dissolved in dilute alcohol. After evaporating off the alcohol and cooling, the substance separated as before; the now aqueous solution was decanted and the slimy residue treated with ether. Ether extracted a fatty oil from this material and caused it to assume a more solid consistence. The substance was then treated with alcohol of 93 p. c. which dissolved a little and converted the remainder into a solid lump so that it could be transferred to a flask and digested with ether. By the continued action of ether the viscid substance was transformed into a loose yellowish powder. After standing under ether for 24 hours the body was filtered out and dissolved in dilute alcohol. This alcoholic solution was filtered and evaporated on the water-bath to a small volume. After cooling, the solution was poured from the gummy substance adhering to the dish, which was washed with water and repeatedly digested with absolute alcohol. As long as the substance retained water, a little dissolved during treatment with alcohol. The

residue became granular and brittle and was easily reduced to a fine powder. When impregnated with absolute alcohol the mass absorbed moisture rapidly from the air and became soft and viscid.

After thorough dehydration with absolute alcohol, the substance was rapidly filtered out and dried over sulphuric acid. It weighed 7.88 grams.

In testing the purity of this substance it was found to yield something to water. The whole preparation was, therefore, washed out completely with distilled water and again treated with absolute alcohol and ether and dried over sulphuric acid. Analysis of this preparation, **9.** gave the following results :

SOLUBLE PROTEID—*Extracted by Weak Alcohol from Ground Oats after treating them with Water.*

9.

	I.	II.
Carbon	53.64	....
Hydrogen	6.88	....
Nitrogen	15.70	15.36
Sulphur	1.75	....
Oxygen	22.03	....
	100.00	

Ash—.6007 gm. air-dried left no ash.

Carbon and Hydrogen—.5886 gm. dried at 110° C. gave 1.1579 gm. CO_2=53.64 p. c. C. and .3642 gm. H_2O=6.88 p. c. H.

Nitrogen. I. Dumas' method—.5000 gm. air-dried =.4479 gm. dried at 110° C. gave 60.68 cc. gas at 8° C. Barometer 757 mm. at 12° C. =15.90 p. c. N, less .20 for blank =15.70 p. c.

II. Kjeldahl method—.5000 gm. air-dried =.4479 gm. dried at 110° C. gave ammonia =8.05 cc. HCl (1 cc. HCl=.00854 gm. N.)=15.36 p. c.

Sulphur—.8958 gm. dried at 110° C. gave .1142 gm. $BaSO_4$=.0157 gm.=1.75 p. c. sulphur.

3. Extraction with Alcohol after treatment with Salt-Solution. Preparations **10** and **11.**

Five pounds of oats were repeatedly treated with 10 per cent. solution of sodium chloride until nothing more was dissolved, and after pressing out as thoroughly as possible, the residue was twice treated with alcohol of .912 sp. gr., being pressed out each time and the extracts kept separate. The first and second alcohol-extracts were united, evaporated on the water bath, until all alcohol had escaped and the residue was cooled to 10° C. At this

temperature the deposit formed brittle lumps which, after decanting the solution, were treated with ether and absolute alcohol. The lumps were thus brought into a granular state, in which condition the substance was treated for some time with ether until all fat was removed. It was then dissolved in hot dilute alcohol, filtered and evaporated on the water-bath to a small volume. On cooling the proteid separated in a mass on the bottom of the dish. The aqueous liquid was poured off and the residue treated with absolute alcohol and ether, whereupon it became brittle and was easily ground to a fine powder. This powder was washed with water until it no longer gave with silver nitrate a reaction for chlorine. It was then treated with absolute alcohol and dried over sulphuric acid. In appearance and behavior it resembled in all respects the substance extracted by alcohol after the oats had been treated with water. When analyzed it was found to have the composition stated under **10.**

The third alcoholic extract of the oats was treated in the same way, and the product obtained analyzed with the following results, **11:**

SOLUBLE PROTEID—*Extracted by Weak Alcohol from Ground Oats after treating them with Salt-Solution.*

	10.			11.	
	I.	II.	III.	I.	II.
Carbon	53.97	----	----	53.55	----
Hydrogen	7.14	----	----	6.80	----
Nitrogen	15.71	15.66	15.68	15.61	15.52
Sulphur	1.80	----	----	24.04	----
Oxygen	21.38	----	----		
	100.00			100.00	
Ash	.56			.25	

Details of Analyses of **10.**

Ash—1 gm. air-dried =.9361 gm. dried at 110° C. gave .0053 gm. ash =.56 p. c.

Carbon and Hydrogen—.3443 gm. dried at 110° C. gave .6780 gram CO_2=53.70 p. c. C, and .2200 gm. H_2O=7.09 p. c. H.

Nitrogen—I. Dumas' Method—.5000 gm. air-dried =.4681 gm. dried at 110° C. gave 60.47 cc. gas at 8° C. Barometer 772 mm. at 8° C.=15.80 p. c. less .20 for blank =15.60 p. c. N.

II. Kjeldahl Method—.5000 gm. air-dried =.4681 gm. dried at 110° C. gave ammonia =8.53 cc. HCl (1 cc. HCl =.00854 gm. N.)=15.57 p. c. N.

III. .5000 gm. gave ammonia 8.55 cc. HCl=15.59 p. c. N.

Sulphur—1 gm. air-dried substance =.9361 gm. at 110° C. gave .1232 gm. $BaSO_4$=.0169 gm.=1.80 p. c. Sulphur.

Details of Analyses of **11.**

Ash—.8680 gm. dried at 110° C. gave .0022 gm. ash=.25 p. c.

Carbon and Hydrogen—.3676 gm. dried at 110° C. gave .7190 gm. CO_2=53.42 p. c. C, and .2242 gm. H_2O=6.78 p. c. H.

Nitrogen—I. Kjeldahl Method—.5000 gm.=.4715 gm. dried at 110° C. gave ammonia=8.60 cc. HCl (1 cc. HCl=.00854 gram N)=15.59 p. c. N.

II. .5000 gm.=.4715 gm. dried at 110° C. gave ammonia=8.55 cc. HCl=15.49 p. c. N.

4. Extraction with Alcohol after treatment with Water and Salt-Solution. Preparation **12.**

Five pounds of oats were extracted with water and then with 10 p. c. salt-solution as long as anything was removed. The residue was twice digested with alcohol of .9 sp. gr., the two alcohol-extracts were united and concentrated to a small volume on the water-bath. After cooling, the substance which deposited was filtered out and dissolved in dilute alcohol. The filtered solution was evaporated until nearly all the alcohol was expelled and finally poured into cold water. The abundant precipitate thus produced settled rapidly, forming a pasty mass on the bottom of the dish, from which the water could be completely decanted. By treatment with ether and absolute alcohol the substance was rendered dry and brittle, and was easily ground to a yellowish powder. This was transferred to a flask and digested for 24 hours with a mixture of absolute alcohol and ether, then washed with ether to remove the alcohol and dried in the air. The product weighed 12 grams. After dissolving this preparation in dilute alcohol and evaporating to a small volume on the water-bath, the concentrated solution was poured into a liter of cold distilled water. The substance thus precipitated was washed by decantation with distilled water until all chlorides were removed, then treated with absolute alcohol and ether and dried over sulphuric acid. This preparation was found to have the following composition :

SOLUBLE PROTEID—*Extracted by Weak Alcohol from Ground Oats after treating them with Water and with Salt-Solution.*

12.

	I.	II.
Carbon	53.63	....
Hydrogen	7.16	....
Nitrogen	15.83	15.86
Sulphur	1.74	....
Oxygen	21.64	....
	100.00	
Ash	.11	

Ash—.7593 gm. dried at 110° C. gave .0008 gm. ash = .11 p. c.

Carbon and Hydrogen—.2850 gm. dried at 110° C. gave .5595 gm. CO_2 = 53.58 p. c. C, and .1836 gm. H_2O = 7.15 p. c. H.

Nitrogen—I. Dumas Method—.4168 gm. dried at 110° C. gave 56.95 c. c. N at 18° C. Barometer 764.5^{mm} at 22° C. = 15.81 p. c.

II. Kjeldahl Method—1.0183 gm. dried at 110° C. gave ammonia = 19.63 c. c. HCl (1 cc. HCl = .00822 gm. N) = 15.84 p. c.

Sulphur—.9682 gm. dried at 110° C. gave .1218 gm. $BaSO_4$ = .01673 gm. sulphur = 1.74 p. c.

Recapitulation.

The following statement brings together the analyses of the four preparations last described.

PROTEID EXTRACTED FROM OATS BY WEAK ALCOHOL.

After treatment of the meal with—

	Water.	Salt-solution.		Water and Salt-sol.	
	9.	10.	11.	12.	Average.
Carbon	53.64	53.97	53.55	53.63	53.70
Hydrogen	6.88	7.14	6.80	7.16	7.00
Nitrogen	15.70	15.71	15.61	15.83	15.71
Sulphur	1 75	1.80	24.04	1.74	1.76
Oxygen	22.03	21.38		21.64	21.83
	100.00	100.00	100.00	100.00	100.00

When the above analyses are compared, as below, with those of the preparations obtained without previous treatment of the oats with water or salt-solution, it is evident that we have in hand two quite different and distinct substances, neither of which agrees in composition with Kreusler's *Oat-Gliadin.*

PROTEID EXTRACTED FROM OATS BY WEAK ALCOHOL.

	Without action of water or Salt-Solution.	After action of water or Salt-Solution.
	8.	Average.
Carbon	53.06	53.70
Hydrogen	6.94	7.00
Nitrogen	16.38	15.71
Sulphur	2.26	1.76
Oxygen	21.36	21.83
	100.00	100.00

The differences in behavior of the two substances are much more marked than those of composition. The body extracted by

alcohol without the previous treatment with water becomes insoluble in alcohol with great readiness and after having been dissolved and precipitated a few times is again dissolved very slowly and only in a large amount of hot alcohol of .9 sp. gr. When wet with absolute alcohol it can be exposed to moist air without becoming gummy.

On the other hand, the body extracted by alcohol after the action of water or 10 p. c. salt-solution shows no tendency to become insoluble even after long heating with very dilute alcohol. It is freely soluble even in cold alcohol of .9 sp. gr., and when wet with absolute alcohol it immediately attracts moisture from the air, becoming sticky and viscid. In appearance the two bodies do not materially differ, both being light yellowish powders when prepared as described.

Both these substances are soluble in dilute acids and alkalies to solutions from which on neutralization they precipitate, retaining solubility in dilute alcohol.

The fact that weak alcohol acts as a solvent on these bodies, which are insoluble in either pure (absolute) alcohol or pure water, is doubtless due to the formation of hydrates that, while insoluble in water, are soluble in alcohol, but that cannot exist in strong alcohol, being thereby dehydrated.

The proteid whose composition is expressed by analysis 8, was first obtained by Norton, who extracted ground oats directly with hot alcohol, distilled the solution carefully to dryness, dissolved out the oil by ether and the salts and sugar by water. Norton designated this body *Glutin*, and considered it "analogous to the glutin of wheat;" he states that the preparation which he thus separated and weighed was no longer soluble in alcohol, but he did not attempt any further investigation of its properties or composition (*Am. Jour. Sci.*, 2d Ser., III. 229).

Von Bibra who found in oats 3.00 p. c. of *Plant-gelatin* (Pflanzenleim), does not describe its mode of preparation, but states that it contained 15.6 p. c. of nitrogen.

Kreusler indeed extracted crushed oats directly by 80 p. c. alcohol, and in his first preparations, found 16.22 and 16.21 p. c. of nitrogen; but the substance, from whose analysis he decided upon the composition of *Oat-gliadin*, had been "purified" by dissolving in acetic acid and precipitating by potash-solution, and according to his results, contained 1.3 p. c. more nitrogen, 0.65 p. c. more hydrogen and, 0.6 p. c. less sulphur than exists in either of the alcohol-soluble proteids which I have analyzed.

It would be premature to attempt a revision of the nomenclature of these proteids until after re-investigating the alcohol-soluble proteids of the other cereals.

IV. Proteids extracted by Water.

The water-extract of freshly ground oats has a strong acid reaction. The acidity measured by litmus is much less than by phenol-phthalein. 100 cc. of an aqueous extract became neutral to delicate litmus paper after adding 10 cc. of 2-tenths p. c. KOH solution, and 5 cc. more of the same solution were added before phenol-phthalein showed an alkaline reaction. On neutralizing the water-extract of oats with 2-tenths p. c. potash, using phenol-phthalein as an indicator, a considerable precipitate appeared which was soluble in the slightest excess either of alkali or of the acid contained in the extract. This neutralization-precipitate indicates the presence of so-called *Acid-albumin.* The perfectly neutralized solution when heated to boiling remained clear. On adding 10 p. c. of sodium chloride to the neutralized and filtered liquid a considerable precipitate formed upon boiling as well as on the addition of acetic acid. When the unneutralized extract was boiled and the resulting coagulum filtered off, neither sodium chloride nor acetic acid gave a precipitate in the filtrate on boiling. The substance remaining in solution after neutralization, but precipitated by boiling, in the presence of sodium chloride or on the addition of acetic acid, is a *Globulin,* to be described later.

The water-extract, when heated slowly in a test tube immersed in a beaker of water which in turn was set in a larger beaker of water, showed a turbidity first at 57° C. and minute flocks appeared at 64° C. Heated to 70° and filtered, the solution remained clear until raised to boiling, when a slight precipitate formed. When 10 p. c. of sodium chloride was added to the extract, the turbidity appeared at 44° C. and flocks formed at 64° C.

Five pounds of oats were treated with 6 liters of water for 24 hours, pressed out and extracted a second time for 24 hours with the same amount of water. The aqueous extract reacted strongly acid to litmus, but was not neutralized as the possible action of the acid was kept in mind and the immediate object in view was to find what substances were extracted by the use of water

alone. The two extracts were united, saturated with commercial ammonium sulphate and the precipitate thereby resulting was filtered off, and scraped from the filter, the paper was washed out with water, the solution being added to the dark olive-green precipitate which partly dissolved to a brown solution. After the solution and suspended precipitate had dialyzed for 14 days in a stream of running water, thymol being added to prevent decomposition, the solution was found to be nearly free from sulphate. The contents of the dialyzer were then filtered from a dark green precipitate which had not dissolved on removing the salts. The filtrate was found not to coagulate on boiling and was evaporated to dryness on the water-bath, leaving a brown residue which weighed between 1 and 2 grams and gave the following reactions.

With the biuret test it yielded a red-purple color, of a bluer tint than given by peptones or albumose, which increased on standing. Millon's reagent with the aqueous solution gave a strong reaction. Alcohol of .9 sp. gr. dissolved a portion which, after removal of the alcohol, was readily soluble in water and reacted for proteids with Millon's reagent and the biuret test. After evaporation of the alcohol on the water-bath, the substance was but partially soluble in water. The alcoholic solution was precipitated by adding stronger alcohol. Fehling's solution gave no reaction until after heating with dilute acid, when a very slight precipitate of Cu_2O appeared. Very dilute HCl gave no precipitate in the solution, and stronger acid made a slight turbidity. These reactions indicate presence of a *Proteose* and absence of true *albumin*.

The substance remaining after dialyzing the ammonium sulphate precipitate was treated with 10 p. c. brine of sodium chloride; the resulting solution was filtered off and dialyzed till free from chlorides. Nothing precipitated on removal of the salt, the proteid being soluble in water. This fact shows that no globulin had been extracted from the substance which separated on dialysis of the aqueous extract, the globulin having been converted into an insoluble form. This dialyzed solution was not coagulated by boiling, and was therefore evaporated to dryness on the water-bath. The residue, weighing about 1 gram, was not quite completely soluble in water. As much as possible was dissolved in a small amount of water, and filtered from a slight residue. The solution was colored deep yellow-brown, contained a trace of chlorides, gave no precipitate with hydrochloric acid,

either very dilute or strong. No biuret reaction was discernible in the colored solution, which gave the proteid coloration with Millon's test, and did not reduce Fehling's solution before treatment with acids. On long standing, after heating with HCl, a little Cu_2O separated. Evidently this substance is the same (*proteose?*) as that obtained from the solution remaining after dialyzing the ammonium sulphate precipitate.

The substance remaining after dialysis and insoluble both in water and in 10 p. c. brine was found to be partly taken up in ½ p. c. sodium carbonate solution, and in dilute hydrochloric acid, being the result of the alteration of globulin, which had passed into solution, by means of the salts derived from the oats. The neutralization-precipitate from sodium carbonate solution was slightly soluble in 10 p. c. brine of sodium chloride. The fact that the ammonium sulphate used in this work was crude and had a slightly acid reaction and a bluish tint, to which the green color of the precipitate was due, may throw doubt on the results here recorded, but as they were mostly corroborated on repeating the trials with pure and neutral ammonium sulphate, I have given them in detail.

The results of a second examination of water-soluble proteids here follow. Five pounds of oats were treated with 7 liters of water for 48 hours, thrown on a sieve, the residue pressed out and treated for a short time with 6 liters more of water. The two extracts were united and allowed to settle, when the nearly clear liquid was syphoned off and saturated with pure ammonium sulphate. After the white precipitate thus produced had stood over night, it separated in large flocks from the liquid, and was filtered out and dissolved mostly in 10 p. c. NaCl-brine, filtered and the clear solution dialyzed. The precipitate was not completely soluble in 10 p. c. NaCl-brine nor in water, in these respects resembling the precipitate obtained from the first extract after it had been dialyzed. The clear filtered solution in 10 p. c. NaCl-brine, on standing slowly deposited a part of the dissolved substance. The solution, with the precipitate which had formed, was dialyzed until free from salts, and the solution after filtering again was evaporated to dryness on the water-bath, leaving a residue of 1.11 grams. The precipitate filtered out was quite small in amount. The total proteid obtained by saturating with ammonium sulphate was less than that got in the first extraction, probably because the oats were allowed to stand twice as long in con-

tact with water as in case of the first extract, for it was found that the clear, filtered extract of the ammonium sulphate precipitate in 10 p. c. NaCl-brine, on standing deposited the dissolved substance, so that before the conclusion of the dialysis nearly all the proteid originally soluble in water had lost its solubility.

Weyl states that water converts vegetable globulins into "albuminates," that is into forms no longer soluble in salt-solutions but soluble in 1 p. c. Na_2CO_3 solution, or .8 p. c. HCl, and that a long continued action of water finally converts the albuminates thus produced into modifications that are no longer soluble in 1 p. c. Na_2CO_3 solution, or .8 p. c. HCl. They are then not to be distinguished from "coagulated proteids." This latter change he has observed only for the globulins of peas and oats.

Transformations of this character occurred in the two extracts just described. In the first, after dialysis, the residue insoluble in 10 p. c. NaCl-brine, was partly soluble in ½ p. c. Na_2CO_3 solution, and in the second a body was formed insoluble in water, and in 10 p. c. NaCl-brine but soluble in ½ p. c. Na_2CO_3 solution.

To sum up—We have in the aqueous extract of the oat kernel the following bodies:

1. An *Acid-Albumin*, precipitated by exact neutralization of the extract.

2. One or more *Globulins*, precipitated from the neutralized extract, by sodium chloride and acetic acid; also precipitated by saturation with ammonium sulphate; remaining insoluble in water on dialysis, being, as it would appear, by the action of water, converted into an "albuminate."

3. A *Proteose*, remaining in solution after dialysis of the ammonium sulphate precipitate. This body exists also in the dialyzed solution of the ammonium sulphate precipitate from the sodium-chloride extract.

V. Proteids extracted by Cold Sodium Chloride Solution.

1. Direct Extraction with Salt Solution. Preparations 13 and 14.

Freshly ground oats extracted with 10 p. c. brine of sodium chloride* at 15°–20°, gave a brown solution which, when filtered clear, coagulated as follows: Heated to 42° C. a very slight tur-

* The sodium chloride employed, was the "Diamond Crystal Table Salt," Eureka Salt Company, New York, which is "remarkably free from impurities."

bidity formed, which increased very slowly up to 57°, at which temperature it was still slight. Above this point it increased more rapidly, at 61° the solution being opaque, at 72° flocks formed. Heated at 73° some minutes and then filtered, the filtrate became turbid again at 70°, the turbidity increasing somewhat up to 87°; from 87° to 90° the increase was more rapid, but the amount separated at 90° was small. The solution heated to 90° and filtered, became turbid again at 85° with little change up to 97°. Heated to boiling for a short time and filtered, the filtrate gave an abundant precipitate with acetic acid.

Dilute acetic or hydrochloric acid yields a large precipitate in the brine extract, which is insoluble in a slight excess of the acid. Either saturation with sodium chloride or dilution with water throws down a copious precipitate. The precipitate produced by water, on standing in the dilute salt solution two days, becomes insoluble in 10 p. c. sodium chloride brine and in ½ p. c. sodium carbonate solution.

Saturation with ammonium sulphate completely precipitates the proteids from this solution in 10 p. c. sodium chloride brine.

Five pounds of freshly ground oats were treated twice with 10 p. c. sodium chloride solution, and after filtering, the extract was saturated with commercial but perfectly neutral ammonium sulphate, which gave a dark greenish color to the extracted substances without otherwise affecting their properties. The bulky precipitate was filtered off, suspended in water and dialyzed 14 days, until nearly free from sulphates.

A heavy precipitate remained undissolved. This was filtered out and the filtrate and precipitate were separately examined.

Filtrate.—When heated very slowly in a test tube, in the manner previously described, the solution was found to become turbid at 58° C.; at 70° C. flocks were formed. Heated to boiling and filtered, the filtrate gave a strong reaction with Millon's reagent. The entire solution was therefore concentrated to a small volume at 40° C. and dialyzed until all salts were removed. The coagulation-point of the solution was again taken and found to be the same as before; turbidity at 58° C.; flocks at 73° C. The solution was strongly colored, appearing almost black by reflected light, and by transmitted light a greenish brown. It gave good biuret and Millon's reactions; was not affected by very dilute hydrochloric acid but was precipitated by stronger acid in the cold. Fehling's solution suffered no reduction, either before

or after the action of acid. This solution was then evaporated on a plate below 50° C. and yielded about 6 grams of a very brittle, greenish-black shining substance, very soluble in water, from which alcohol of .9 sp. gr. dissolved some proteid.

It is seen that when oats are extracted with 10 p. c. NaCl-solution, a substance soluble in water and coagulating at 58° to 73° C. is formed, which does not exist in the oats originally, for the aqueous extract, when treated in the same way, yields no substance coagulable even upon boiling.

The amount of this coagulable proteid, which has the properties characteristic of an *Albumin*, was too small for analysis (0.5 gram from 2½ kilos. of oats) but its importance in a study of these bodies is great, for Weyl has undertaken to classify the vegetable proteids after the manner now commonly adopted for those of animal origin, and has stated that the extracts of oats and other seeds in 10 p. c. NaCl-solution coagulate at 55° to 60° C. and consequently contain a *myosin*, since the myosin from animal muscle coagulates under these conditions at this temperature. He also states that besides myosin, *vitellin* exists in these seeds, as shown by filtering out the coagulum formed at 60° C. and heating the solution gradually to 75°, when a second coagulation takes place.

The salt-soluble proteid to be described further on, was found, when dissolved in a 10 p. c. NaCl-solution, to become turbid at 81° C. and to form flocks at 97°. This then has a coagulation-point not far from that of vitellin, but it differs from vitellin, in being readily precipitated by sodium chloride even before saturation.

It is seen from the experiments above described that the presence of a very little coagulable substance may be highly misleading, and gives no certain basis for classifying or identifying the vegetable proteids unless each body is separated from all the others and examined in detail by itself. Weyl did not attempt this except for one preparation from the Brazil nut (*Bertholletia*), and therefore his conclusions based on coagulation-points need further study before they can be accepted.

Precipitate.—The precipitate from the dialyzer, filtered out of the solution just considered, was treated with 10 p. c. NaCl-solution. A part of the substance which did not dissolve was filtered out and the clear filtrate dialyzed till free from chlorides when the proteid was found to be precipitated. This precipitate was filtered out, washed with water, absolute alcohol and ether and dried over sulphuric acid.

The *Globulin* thus obtained, **13**, had the following properties:

In 10 p. c. brine of sodium chloride it dissolved readily to a clear solution. Addition of an equal volume of water to this solution produced a copious precipitate. Addition of sodium chloride gave a large precipitate even before saturation. When the solution was diluted till turbid the turbidity disappeared on warming gently.

Very dilute acetic or hydrochloric acid dissolved the substance readily when salts were not present. The addition of more acid gave no precipitate. Addition of a *very* little sodium chloride to a solution of the substance in very dilute acid made a slight precipitate; the addition of more sodium chloride threw down an abundant curdy precipitate. The more acid present, the more salt-solution was required to produce a precipitate, and the more salt-solution present, the less the amount of acid required for precipitation.

Dilute solution of citric acid in water (1 : 2000) gave results like acetic acid and dissolved the substance readily to a solution which was *not* coagulated on boiling.

From solution of the substance in 10 p. c. brine, hydrochloric acid throws down a precipitate which is wholly insoluble even in strong solution of sodium carbonate (the filtrate giving no biuret-reaction), and is also insoluble in an excess of dilute acid. Acetic acid on the other hand gives a precipitate which, at first, is readily soluble in *very* dilute sodium carbonate, but the solution, on standing, becomes turbid.

Hydrochloric acid, in the presence of salt, converts this proteid into a "coagulated proteid," acetic and citric acids transform it into an "albuminate."

The preparation gave the usual reactions with Millon's reagent, with cupric sulphate and potash, and with nitric acid. The solution in 10 p. c. brine of sodium chloride, on heating became turbid at 81° C. and at 97° C. the formation of flocks occurred. The same solution allowed to stand at summer temperature for more than a month, showed no signs of turbidity, decomposition being prevented by adding from time to time a drop of a 20 p. c. alcoholic solution of thymol. The composition of this globulin is given on the next page.

OAT-GLOBULIN—*First direct extraction with* 10 *per cent. Salt-Solution.*

	18.			
	I.	II.	III.	I. Ash-free.
Carbon	52.23	52.22	....	52.32
Hydrogen	7.15	6.99	....	7.19
Nitrogen	16.92	17.07	16.90	16.95
Sulphur	.88	....	....	.88
Oxygen	....	....	....	22.66
Ash	.20	....	....	....
				100.00

Ash.—.7937 gm. gave .0015 gm. ash = .20 p. c.

Carbon and Hydrogen.—I. .3561 gm. gave .6822 gm. CO_2 = 52.23 p. c. Carbon and .2300 gm. H_2O = 7.15 gm. Hydrogen.

II. .4584 gm. gave .8778 gm. CO_2 = 52.22 per cent. Carbon and .2883 gm. H_2O=6.99 per cent. Hydrogen.

Nitrogen.—I. Dumas' Method—.6225 gm. gave 90.85 c. c. Nitrogen at 18° C., Barometer 765.5 mm. at 22° C. = 16.92 p. c.

II. Kjeldahl Method—.5760 gm. gave ammonia = 11.95 c. c. HCl. (1 c. c. = .00822 gm. N.) = 17.07 p. c.

III. 1.0476 gm. gave ammonia = 21.54 c. c. HCl = 16.90 p. c.

Sulphur.—.8022 gm. gave .0513 gm. $BaSO_4$ = .00705 gm. Sulphur = .88 p. c.

A second preparation of Globulin was as follows: Five pounds of ground oats were digested with 8 liters of 10 p. c. sodium chloride solution for 48 hours and pressed out. The residue was again subjected to the same treatment. The two extracts were united, filtered, the clear filtrate saturated with pure ammonium sulphate, and the precipitate thus produced was filtered off. This precipitate was found to be completely soluble in 10 p. c. salt-solution, save a slight turbidity, which was readily cleared up by very dilute sodium carbonate solution. It was therefore removed from the filter, suspended in water and dialyzed for 11 days, whereby the salts were nearly all removed. The precipitate was filtered off and the filtrate and precipitate were separately examined.

Filtrate.—The clear brown filtrate was evaporated to dryness at 50°, leaving an amber-brown, instead of a greenish-black, residue, as was obtained from the first salt-extract.

The properties of this residue agreed exactly with those from the first salt-extract, the difference in color being due to impurities in the ammonium sulphate used in saturating the first extract.

Precipitate.—The precipitate in the dialyzer was found to remain almost entirely soluble in salt solution, the trifling residue not taken up by that solvent yielded to dilute sodium carbonate,

and when this solution was neutralized with a slight excess of acetic acid the separated substance dissolved in solution of common salt.

The dialyzed precipitate was therefore filtered, washed by decantation with water, alcohol, ether, and absolute alcohol, and dried over sulphuric acid. This body had all the properties of the one similarly prepared and already described, **13**. Twenty grams of substance were thus obtained and by extracting the Oat-residue with 10 p. c. sodium chloride solution, until no more proteid was taken up, and proceeding as just detailed, ten grams more of globulin were secured. The yield was accordingly 1.3 p. c. of the air-dry oats. The analyses of this preparation here follow.

OAT-GLOBULIN—*Second direct Extraction with* 10 *per cent. Salt-Solution.*

14.

	I.	II.	III.	I. Ash-free.
Carbon	52.28	52.33	....	52.37
Hydrogen	7.23	7.17	....	7.24
Nitrogen	16.78	16.90	17.01	16.81
Sulphur	.89	....	....	.89
Oxygen	....	....	....	22.69
Ash	.21	....	....	....
				100.00

Ash.—.8060 gm. gave .0017 gm. ash = .21 p. c.

Carbon and Hydrogen.—I. .2894 gm. gave .5545 gm. CO_2 = 52.28 p. c. Carbon and .1883 gm. H_2O = 7.23 p. c. Hydrogen.

II. .2190 gm. gave .4200 gm. CO_2 = 52.33 p. c. Carbon and .1412 gm. H_2O = 7.17 p. c. Hydrogen.

Nitrogen.—I. Dumas' Method—.5314 gm. gave 77.1 c. c. Nitrogen at 18° C., Barometer 763.5 m.m. at 22° C. = 16.78 p. c.

II. Kjeldahl Method—.4732 gm. gave ammonia = 9.73 c. c. HCl (1 c. c. = .00822 gm. Nitrogen) = 16.90 p. c.

III. .9973 gm. gave ammonia = 20.64 c. c. HCl = 17.01 p. c. Nitrogen.

Sulphur.—.8400 gm. gave .0547 gm. $BaSO_4$ = .007513 gm. Sulphur = .89 p. c.

2. Extraction with Salt-Solution after treatment with Alcohol.

PREPARATION 15.

Since digestion of oats first with water or with salt-solution altered the alcohol-soluble proteid, it was thought possible that by preliminary treatment with alcohol a salt-soluble body might be obtained different from the one extracted directly by salt-solution.

To test this hypothesis three pounds of fine-ground oats were extracted, in the cold, three times with 6 liters of alcohol of .9 sp. gr. After pressing out as thoroughly as possible, the residue was treated three times with 10 p. c. sodium chloride solution, the solvent each time being allowed to stand in contact with the oats for 24 hours. The first and second extracts were united, filtered and saturated with sodium chloride. The precipitate was filtered out and found to be but partly soluble in 10 p. c. brine. It was therefore dissolved in solution of sodium carbonate of ¼ p. c., and the filtered liquid was exactly neutralized with acetic acid which separated the proteid as a white precipitate. After washing thoroughly by decantation with distilled water, with dilute alcohol, with ether, and finally with absolute alcohol, the substance was dried over sulphuric acid. As it weighed only 2.1 grams, the greater part of the salt-soluble proteid in the oats had evidently been converted into an "albuminate."

OAT-GLOBULIN—*Extracted by 10 p. c. Salt-Solution after treatment with Alcohol. Dissolved in ¼ p. c. Sodium Carbonate Solution and precipitated by Acetic Acid.*

15.

		Ash-free.
Carbon	52.39	52.48
Hydrogen	6.93	6.94
Nitrogen	16.82	16.85
Sulphur	.57	.57
Oxygen	----	23.16
Ash	.17	----
		100.00

Ash.—.3773 gm. gave .0006 gm. ash = .17 p. c.

Carbon and Hydrogen.—.3187 gm. gave .6122 gm. CO_2 = 52.39 p. c. Carbon and .1993 gm. H_2O = 6.93 p. c. Hydrogen.

Nitrogen.—Dumas' method—.3220 gm. gave 47.17 c. c. Nitrogen at 18° C. Barometer 759.3 m. m. at 28° C. = 16.82 p. c.

Sulphur.—.7435 gm. gave .0304 $BaSO_4$ = .004216 gm. sulphur = .57 p. c.

VI. PROTEIDS EXTRACTED BY WEAK POTASH SOLUTION.

1. Extraction after treatment of the Ground Oats with Alcohol.

PREPARATION 16.

Another extraction was made in nearly the same manner as that employed by Kreusler in preparing his "Oat Legumin:" Five pounds of freshly-ground oats were treated in the cold with

alcohol of .9 sp. gr. as long as any proteid was removed. The residue was digested for some time with 7 liters of $\frac{2}{10}$ p. c. potash-solution. The whole was then thrown on a sieve and the turbid percolate allowed to stand for 24 hours.

The dark-colored solution was syphoned off, let stand another 24 hours, decanted from the slight sediment and then precipitated with very dilute acetic acid. After 24 hours the substance had so far settled that about two-thirds of the liquid could be decanted. To the remainder, alcohol was added until the solution had a sp. gr. of .93. On further standing, the precipitate deposited and was transferred to a filter. It was washed with stronger alcohol, removed from the paper and dissolved again in $\frac{2}{10}$ p. c. potash-solution. A turbid liquid resulted which could not be filtered until a little sodium chloride had been added, which precipitated some of the dissolved proteid. This precipitate was soluble both in additional potash-solution and in brine. More salt was therefore added, the nearly clear solution was then filtered, which process lasted for about a week. Decomposition was entirely prevented by the use of thymol. The filtrate obtained each day was precipitated with dilute acetic acid, the precipitate was washed on a filter with water, then with dilute and afterwards with strong alcohol and was finally transferred to a flask filled with absolute alcohol. When the filtration was completed and the united precipitates had been digested with absolute alcohol, they were treated with ether and again with absolute alcohol and lastly dried over sulphuric acid, yielding preparation **16.**

OAT-PROTEID—*Extracted by $\frac{2}{10}$ p. c. KOH Solution after treatment of the Ground Oats with Alcohol.*

	16.			
	I.	II.	III.	I. Ash-free.
Carbon	52.11	52.18	....	52.45
Hydrogen	6.87	6.74	....	6.92
Nitrogen	16.52	16.48	16.40	16.63
Oxygen	....	....	....	23.19
Sulphur	.81	....	....	.81
Ash	.66	....	....	....
				100.00

Ash.—.7373 gm. gave .0049 gm. ash = .66 p. c.

Carbon and Hydrogen.—I. .3666 gm. gave .7005 gm. CO_2 = 52.11 p. c. Carbon and .2265 gm. H_2O = 6.87 p. c. Hydrogen.

II. .4523 gm. gave .8651 gm. of CO_2 = 52.18 p. c. Carbon and .2746 gm. H_2O = 6.74 p. c. Hydrogen.

Nitrogen.—I. Dumas' method—.3577 gm. gave 51.44 c. c. Nitrogen at 18° C. Barometer 758.7 mm. at 22° C. = 16.52 p. c.

II. Kjeldahl method—.5037 gm. gave ammonia = 10.1 c. c. HCl (1 c. c. HCl = .00822 gm. N) = 16.48 p. c. Nitrogen.

III. 1.0412 gm. gave ammonia = 20.77 c. c. HCl = 16.40 p. c. Nitrogen.

Sulphur.—.8670 gm. gave .0510 gm. $BaSO_4$ = .0070 Sulphur = .81 p. c.

For comparison the analyses of the last four preparations are here stated together.

	13.	14.	15.	16.
Carbon	52.32	52.37	52.48	52.45
Hydrogen	7.19	7.24	6.94	6.92
Nitrogen	16.95	16.81	16.85	16.63
Sulphur	.88	.89	.57	.81
Oxygen	22.66	22.69	23.12	23.19
	100.00	100.00	100.00	100.00

13 and **14.** Extracted directly by 10 p. c. NaCl solution.

15. Extracted by 10 p. c. NaCl solution after treating the ground oats with alcohol, then dissolved in ½ p. c. Na_2CO_3 solution and precipitated by acetic acid.

16. Extracted by $\frac{5}{10}$ p. c. KOH solution after exhausting the ground oats completely with alcohol.

The four preparations agree in composition so closely that it is fair to assume that they were pure and that the analyses correctly represent the composition of one and the same proteid.

Of the above analyses, **13** and **14** represent the composition of oat-globulin as extracted by 10 p. c. solution of pure sodium chloride and still soluble in that menstruum, while **15** and **16** represent the insoluble or "albuminate" modification of the same proteid.

Analysis **15** indicates that the globulin is not essentially changed in composition by being dissolved in weak sodium carbonate solution and precipitated therefrom by dilute acid.*

Since all proteids, except the coagulated, are soluble in weak alkali, analysis **16**, made on a substance extracted by $\frac{5}{10}$ p. c. potash-solution, may be taken to exhibit the composition of whatever uncoagulated proteids remain in the oat after the direct extraction with weak alcohol. The close agreement of **16**

*The low figure for sulphur in **15** is accidental, some loss having been incurred in oxidizing the substance by fusion with alkali-nitrate and carbonate. The determination could not be repeated for lack of material.

with the other analyses leads to the conclusion that the oat-proteids which are not extracted by weak alcohol mainly consist of either the salt-soluble globulin or its "albuminate" modification or else of a proteid from which these are derived under the influence of the solvents employed in their preparation.

The amount of these preparations obtained in a form suitable for analysis was a very small fraction of the total proteid contained in the oats. This was probably due to the conversion of the globulin into an "albuminate" or a "coagulated proteid."

The exact cause of this change has not been ascertained. To test the hypotheses that it might be due to the action of an acid or acid-salt contained in the oats, 100 grams of the freshly ground grain were treated with 800 c. c. of $\frac{2}{10}$ p. c. potash-solution. The resulting mixture was neutral to litmus and did not redden phenolphthalein. Eighty grams of sodium chloride were then added and the solution, after standing some time, was filtered. Very little proteid was thus extracted. In another trial, 10 p. c. solution of sodium chloride mixed with $\frac{2}{10}$ p. c. of sodium carbonate, extracted but a small part of the proteids.

100 grams of oats treated with $\frac{2}{10}$ p. c. solution of sodium carbonate gave an extract containing much proteid, which on addition of a little sodium chloride yielded an abundant precipitate. Neutralizing the sodium carbonate extract, gave a precipitate which was insoluble in sodium chloride solution.

These experiments indicate that the insolubility of the greater part of the oat-proteids in 10 p. c. brine is not due to the presence of an acid or acid-salt.

Weyl has stated that when wheat flour is extracted with sodium chloride solution, the residue yields no gluten on kneading with water, and he considers that the gluten does not preëxist in the wheat but is a product of ferment action. It was thought that if a ferment occasioned alteration of oat-proteids, its effect might perhaps be prevented by treating the ground oats with a sodium chloride solution heated to 75° C. so that all the soluble proteids coagulable below that temperature would be rendered insoluble and inoperative as ferments. The globulin coagulating at 80° C. ought not to be affected by this treatment. Experiments made to prove this view did not result in the extraction of much if any more globulin than was obtained when a cold salt solution was employed.

The trials next to be described have an important bearing on the alterations of proteids which take place in the presence of water.

2. Direct Extraction of the Ground Oats with weak Potash-Solution. Preparation **17.**

100 grams of freshly ground oats were treated with 500 c. c. of $\frac{2}{10}$ p. c. potash-solution. The mixture, after standing some time, was found to be neutral to litmus paper. It was then strained through a coarse cloth to remove the husks and the residue was treated with 100 c. c. of $\frac{2}{10}$ p. c. potash solution and squeezed out nearly dry. The solutions and washings were united and 100 c. c. $\frac{2}{10}$ p. c. potash-solution added thereto, making 700 c. c. in all. The liquid was then faintly alkaline to litmus. On standing the insoluble matter settled out; the solution was decanted, filtered and the residue treated again with $\frac{2}{10}$ p. c. potash-solution. The first potash-extract was very dark brown in color, the second much lighter. A third extract contained very little proteid. The first and second extracts were united, filtered and precipitated with acetic acid added to acid reaction, washed thoroughly with water, alcohol and ether and dried over sulphuric acid. The preparation weighed 7.8 grams. A portion treated with $\frac{2}{10}$ p. c. potash-lye was completely soluble giving a perfectly clear solution. The rest of the preparation was treated with hot alcohol of .9 sp. gr. which took up a little proteid. It was washed with hot alcohol of .9 sp. gr. until nothing more was removed, then with absolute alcohol and finally with ether and was dried over sulphuric acid. After drying at 110° C. the substance was analyzed with the following results:

OAT-PROTEID.—*Directly extracted with $\frac{2}{10}$ per cent. KOH-Solution.*

17.

			Ash-free.	
	I.	II.	I.	II.
Carbon	52.96	----	53.49	----
Hydrogen	6.93	----	7.01	----
Nitrogen	16.23	16.10	16.39	16.26
Sulphur	.98	----	.99	----
Oxygen	----	----	22.12	----
Ash	1.00	----	----	----
			100.00	

Ash.—.7063 gm. dried at 110° gave .0071 gm. of Ash=1.00 p. c.

Carbon and Hydrogen.—.2651 gm. gave .5148 gm. CO_2=52.96 p. c. C, and .1654 gm. H_2O=6.93 p. c. H.

Nitrogen.—I. Kjeldahl Method—.7395 gm. gave ammonia=14.6 cc. HCl (1 cc.= .00822 gm. N)=16.23 p. c. N.

II. Dumas' Method—.4285 gm. gave 59.82 cc. Nitrogen at 15° C, Barometer 751.5 mm. at 21° C.=16.10 p. c. N.

Sulphur.—.5196 gm. gave .0373 gm. $BaSO_4$=.00512 gm. Sulphur=.98 p. c.

3. Extraction of the Ground Oats with weak Potash-Solution after One Hour's treatment with Water. Preparation **18.**

One hundred grams of ground oats were next treated with 800 c. c. of water, the mixture was passed through a cloth to remove husks and the residue washed with 200 c. c. of water. The liquid, with suspended starch, etc., was made up to the volume of a liter and after the oats had been for an hour in contact with the water an equal volume of $\frac{2}{10}$ p. c. potash-solution was added and intermixed.

After standing over night the strongly colored solution was decanted from the residue, filtered, precipitated with acetic acid, the precipitate washed with hot alcohol until nothing more could be removed and then with absolute alcohol and ether and dried over sulphuric acid. This preparation weighed 4.25 grams. The residue was treated a second time with $\frac{2}{10}$ p. c. solution of potash and *very little* more proteid was extracted. After drying at 110° C., this preparation was analyzed with the following results:

OAT-PROTEID—*Extracted by $\frac{2}{10}$ p. c. KOH-Solution after 1 Hour's Contact of the Ground Oats with Water.*

	18.			
			Ash-free.	
	I.	II.	I.	II.
Carbon	51.51	----	52.36	----
Hydrogen	7.16	----	7.27	----
Nitrogen	16.95	17.03	17.23	17.31
Sulphur	.69	----	.70	
Oxygen	----	----	22.44	
Ash	1.63	----	----	
			100.00	

Ash.—.2760 gm. dried at 110° C. gave .0045 gm. ash=1.63 p. c.

Carbon and Hydrogen.—.2953 gm. gave .5576 gm. CO_2=51.51 p. c. C, and .1904 gm. H_2O=7.16 p. c. H.

Nitrogen.—I. Kjeldahl Method—.5867 gm. gave ammonia=12.1 cc. HCl (1 cc.= .00822 gm. N)=16.95 p. c.

II. Dumas' Method—.5120 gm. gave 75.49 cc. N at 15° C., Barometer 753.6 mm. at 23° C.=17.03 p. c.

Sulphur.—.7210 gm. gave .0365 gm. $BaSO_4$=.005013 Sulphur=.69 p. c.

In this analysis the fusible ash made the combustion of the last traces of carbon difficult; hence probably ash and nitrogen are stated a little too high and the carbon is slightly inaccurate.

4. Extraction with Potash Solution after 24 Hours' contact of the Ground Oats with Water. Preparation **19.**

100 grams of oats were treated in the manner just described except that instead of the 1000 c.c. of potash solution first added, 1000 c.c. of distilled water were used. After standing 24 hours the aqueous solution which had become clear was decanted and 1000 c.c. of $\frac{1}{10}$ p. c. potash-solution were added to the residue and let stand upon it over night. The solution was then decanted from the residue, filtered, precipitated with acetic acid, the precipitate was washed with hot alcohol of .9 sp. gr. and with absolute alcohol and ether and dried over sulphuric acid. The preparation weighed 2.55 grams. The following figures were obtained in its analysis.

OAT-PROTEID—*Extracted by $\frac{1}{10}$ p. c. KOH-Solution after 24 Hours' Contact with Water.*

	19.	Ash-free.
Carbon	52.29	52.61
Hydrogen	6.88	6.92
Nitrogen	16.89	16.99
Sulphur	.89	.89
Oxygen	22.46	22.59
Ash	.59	----
	100.00	100.00

Ash.—.5578 gm. dried at 110° C. gave .0033 gm. ash = .59 p. c.

Carbon and Hydrogen.—.3300 gm. gave .6327 gm. CO_2 = 52.29 p. c. C, and .2042 gm. H_2O = 6.88 p. c. H.

Nitrogen.—Kjeldahl Method—.5426 gm. gave ammonia = 11.15 c.c. HCl. (1 c.c. = .00822 gm. N) = 16.89 p. c.

Sulphur.—.8310 gm. gave .0543 gm. $BaSO_4$ = .00746 gm. Sulphur = .89 p. c.

The three preparations last described were made by extraction with the same dilute potash-solution and under essentially the same conditions in all respects, with the single difference, that while in case of **17**, the oats were directly treated with this solvent, **18** was extracted by potash-solution after the ground oats had been kept in contact with water for 1 hour, and **19** after digestion with water for 24 hours.

The amount of proteid extracted in the first instance was 7.80 gm. **17.**
" " " " second " 4.25 gm. **18.**
" " " " third " 2.55 gm. **19.**

The composition of the three preparations is placed in comparison with that of the oat-globulin **13**, in the subjoined statement.

OAT-PROTEID.

	Extracted by— NaCl solution. Direct.	Potash Solution— Direct.	Potash Solution— After contact with water for 1 hour.	Potash Solution— After contact with water for 24 hrs.
	13.	**17.**	**18.**	**19.**
Carbon	52.32	53.49	52.36	52.61
Hydrogen	7.19	7.01	7.27	6.92
Nitrogen	16.95	16.39	17.23	16.99
Sulphur	.88	.99	.70	.89
Oxygen	22.66	22.12	22.44	22.59
	100.00	100.00	100.00	100.00

The experiments just detailed tend to show that the action of water upon the crushed oat-kernel induces rapid changes of composition in these proteids simultaneously with their conversion into insoluble modifications.

They also indicate that the *globulin* itself is a result of changes brought about in the presence of water and is not a body existing as such, ready-formed, in the oats.

5. Norton's Avenine and Kreusler's Oat-Legumin.

The substance extracted directly by potash-solution without previous exposure of the oats to water **17**, is probably the same as that which Johnston and Norton originally termed *Avenine* and which the latter obtained by digesting ground oats in water to which a little ammonia was added to prevent souring, as the weather was very warm (Am. Jour. Sci., 2 Ser., v, p. 23). The preparation which Norton analyzed, as Avenine, was however extracted by water alone and was accordingly a mixture (loc. cit., p. 28). Both Norton and Kreusler applied weak alkali-solution to the extraction of proteid bodies from oats *after* the ground grain had been subjected to the action of water.

Norton made and analyzed two preparations, accomplishing the extraction by means of dilute ammonia, and threw down the proteid by adding acetic acid to the ammoniacal solution. One preparation **A**, was redissolved in strong ammonia at nearly the boiling point and again precipitated by acetic acid, then washed (presumably with water), and boiled in alcohol and ether until no more fatty matter was taken up. Another preparation B, was boiled in alcohol and ether *before* re-dissolving in very dilute ammonia at 70° to 80° C.

Norton made a single analysis of A and two fairly accordant analyses of B, the average of which is the basis for the corrected analysis given below. He found in both substances 1 p. c. of phosphorus which he includes in the analyses reckoned ash-free. This phosphorus in A nearly equals and in B exceeds the ash. If this phosphorus be deducted and the analyses recalculated to a per cent. statement we have the corrected analyses given below. As Norton published no analytical details and used a method of doubtful accuracy (Berthier's) for estimating phosphorus, this correction is perhaps not altogether satisfactory. Norton's nitrogen determinations were all made by Dumas' method. Norton gives to this substance no special name but designates it as a "protein body" simply.

Kreusler's preparation of *Oat-legumin* **A**, was obtained by suspending 1½ pounds crushed oats in 5 liters of water adding, to neutralize the acidity, over 3 grams of potassium hydroxide. The mixture stood 12 hours in a cool place, was then thrown on a sieve, the residue washed with water and the liquid left to rest over night. The turbid liquid was poured off and acidified with acetic acid. The precipitate was washed first with alcohol of 40 p. c. then with that of 80 p. c. then with ether, and lastly, was treated with absolute alcohol and dried over sulphuric acid and at 100°. To purify this substance from starch it was dissolved in dilute potash (1 gram to the liter of water) and from the solution after deposition of all suspended matter, it was thrown down again by acetic acid and washed and dried.

Another preparation B, was obtained from oats that had been extracted by cold alcohol—and a third C, from oats exhausted with hot alcohol—previous to treatment with weak potash-solution. The analyses of A and C, corrected by deduction of ash and phosphoric acid, are here tabulated. In his preparation B, Kreusler found 16.74 p. c. of nitrogen but carried the analysis no further.

PROTEID *obtained from Ground Oats after treatment with Water by extracting with weak solution of—*

	Ammonia. Norton.		*Potash.* Kreusler.	
	A	B	A	C
Carbon	53.72	52.35	52.09	51.58
Hydrogen	7.00	6.93	8.03	8.01
Nitrogen	16.94	16.55	16.83	17.61
Sulphur	.60	1.12	0.96	----
Oxygen	21.74	23.05	22.09	----
	100.00	100.00	100.00	

Norton remarks of his preparation **A** that dissolving it in hot strong ammonia would seem to have darkened the color and somewhat affected the composition. It will be observed that Norton's **B** does not differ greatly from my analyses **13** and **19**.

Kreusler doubting the purity of his preparations boiled them in alcohol of 60 p. c. and finding that something was thereby dissolved, especially from **A**, continued this treatment as long as anything was removed. The dissolved substance contained 16.38 p. c. of nitrogen. The thus "purified" preparations had the following composition, ash-free :

	A	C	Average.
Carbon	51.40	51.85	51.63
Hydrogen	7.49	7.49	7.49
Nitrogen	17.29	17.03	17.16
Sulphur	0.85	0.73	.79
Oxygen	22.97	22.90	22.93
	100.00	100.00	100.00

The average of the last two analyses Kreusler gives as expressing the composition of OAT-LEGUMIN.* He observes, in concluding his paper, that the substance purified by long boiling with alcohol had almost entirely lost solubility both in potash and acetic acid. It was in fact converted into coagulated proteid; but, that the change of composition was not entirely due to the removal of impurities and in part at least was owing to alteration of the substance itself, must be regarded as almost certain.

It is to be concluded that the "globulin" extracted by 10 p. c. salt-solution and the "legumin" removed by dilute potash solution after action of water upon the crushed grain, are very similar, perhaps identical in composition, and that neither of them pre-exists in the grain; but the investigation on these points is not altogether conclusive and needs to be continued.

Assuming that Kreusler's analyses are correct there can be little doubt that his Oat-legumin as finally analyzed was different from

*In a paper already referred to (Pflüger's Archiv., xviii, 236), Ritthausen decided that the soda-lime method used by Kreusler was untrustworthy and stated, as the result of his own analysis by Dumas' method, the nitrogen-content of *Oat-legumin* to be 17.45 p. c. It is now well understood that Dumas' method, carried out as Ritthausen describes, in the paper referred to, usually gives too high results due to retention of air in the oxide of copper, etc., and formation of carbon monoxide during the combustion. See report of this Station for 1878, p. 111 and for 1879, p. 124.

the proteid at first existing in the potash-extract, and was essentially altered in composition as well as in solubility, during the processes of preparation and "purification."

VII. Proteid extracted by Hot Sodium Chloride Solution.

Preparation 20.

Freshly-ground oats were treated with distilled water heated to 65° C. and then sodium chloride was added sufficient to make a 10 per cent. solution. When the addition of salt was begun the liquid had a temperature of 60° C.; when finished, the temperature was 45°. The mixture was digested for about an hour at 45° and a portion of the extract was filtered. The filtrate became turbid immediately on cooling. When gently warmed the turbidity completely disappeared. The perfectly clear solution on further heating coagulated as follows: at 57° C. a very slight turbidity was seen that increased but little up to 78°, whence it rapidly augmented with formation of flocks at 85°.

The remainder of the extract together with the crushed oats was heated up to 75° and filtered as rapidly as possible. A perfectly clear filtrate was obtained which became turbid on cooling. The vessel containing the hot extract was placed in a large water-bath at 75° and cooled very slowly. A dense deposit formed which closely adhered to the bottom of the dish and under the microscope was seen to consist entirely of minute *spheroids* about $\frac{1}{100}$th of a millimeter in diameter.

The residual oats extracted twice again, yielded little more to the hot salt-solution. The proportion of proteid thus obtained was apparently little if any greater than that dissolved by sodium chloride solution at 15° to 20°.

The deposit of spheroids was almost wholly freed from the mother-liquor by simple decantation and was treated with cold 10 per cent. sodium chloride solution in which it dissolved very slowly. On warming to about 40° the substance melted to a soft plastic mass which became softer as the temperature rose, and could be drawn out into glistening threads. At 65° the substance became so fluid that the mass broke up and rapidly dissolved to a clear solution.

When a portion of this solution was heated to 78° a slight turbidity developed that increased very little up to 98° at which point a few flocks separated. These were filtered out and the filtrate gave on boiling a considerable coagulum. The filtrate from this coagulum yielded another precipitate on boiling again

and the same result followed these operations to the fourth time. The final filtrate gave with hydrochloric acid a copious precipitate.

This substance was now prepared in greater quantity in the following manner. Five pounds of ground oats were treated with twelve liters of 10 per cent. sodium chloride solution, strained through a hair sieve to remove the husks and then heated to 60° in a water-bath of 70° and maintained at that temperature for an hour. The extract was then filtered as rapidly as possible. The extract after decanting from a deposit which separated out on cooling, was saturated with pure ammonium sulphate and the precipitate thus formed was filtered off and added to the deposit formed on cooling. The substance thus obtained was then treated with three liters of 10 per cent. sodium chloride solution heated to 65° in a water-bath of 70° and filtered as rapidly as possible on a funnel surrounded by hot water. The clear filtrate, which became turbid at once on cooling, was received in a vessel set in a large water-bath heated to 70° and the whole was allowed to cool very slowly. When cold the liquid was decanted from the dense deposit that adhered to the bottom and sides of the beaker.

As the substance dissolved to an opalescent solution in distilled water, it was washed with 50 per cent. alcohol as long as any chlorine was discoverable in the washings with silver nitrate, then with absolute alcohol, and with ether and dried over sulphuric acid ; 8.5 grams of substance were thus obtained. The salt-solution from which the spheroids had deposited was next dialyzed and the proteid which separated out on the removal of the salts was filtered off, washed in succession with dilute alcohol, absolute alcohol, and ether, and dried over sulphuric acid. This preparation weighed 5.64 grams.

The residue of the oats was extracted a second time in the same manner and the solution was at once saturated with ammonium sulphate. The precipitate thus produced was washed directly with 50 per cent. alcohol, but since the substance dissolved on washing with dilute alcohol as long as much ammoniun sulphate remained, the final yield was only 2.6 grams.

The product obtained from the solution of the first ammonium sulphate precipitate in hot brine has the following properties. Under the microscope, before washing, it appears to be perfectly homogeneous and to consist entirely of spheroids about $\frac{1}{100}$th of a millimeter in diameter. After washing and drying it forms a

dense snow-white powder. In cold distilled water it dissolves to an opalescent solution which gives a heavy precipitate on the addition of a little sodium chloride; a little more sodium chloride precipitates the aqueous solution almost completely and on addition of still more salt this precipitate is again dissolved.

Hot distilled water dissolves this proteid completely to a perfectly clear solution from which a considerable part of the substance deposits on cooling.

Dilute acetic acid alone gives no precipitate in the aqueous solution. Addition of a little salt together with the acid precipitates it. The precipitate thus produced is soluble in alcohol of .9 sp. gr.

When treated with hot dilute alcohol the substance melts and remains suspended in the solution in transparent droplets; addition of either a little salt or a little acetic acid produces no change but both together give a clear solution. This solution in alcohol on cooling forms a very bulky transparent jelly. On evaporation, the substance separates as a skin on the surface which is readily soluble again in dilute alcohol of .9 sp. gr.

On analysis the composition of the dried spheroids was found to be as follows:

OAT-PROTEID—*Extracted by Sodium Chloride Solution at* 65° *C.*

20.

			Ash-free.	
	I.	II.	I.	II.
Carbon	52.13	52.16	52.20	52.24
Hydrogen	6.93	7.02	6.94	7.03
Nitrogen	17.72	17.87	17.75	17.90
Sulphur	.81	.73	.81	.73
Oxygen	----	----	22.30	22.10
			100.00	100.00

Ash—.4694 grams substance dried at 110° C. gave .0009 grams of ash = .19 per cent.

Carbon and Hydrogen—I. .3639 gram dried substance gave .6955 gram CO_2 = 52.13 per cent. C, and .2270 gram H_2O = 6.93 per cent. H.

II.—.4728 gram dried substance gave .9036 gram CO_2 = 52.16 per cent. C, and .2985 gram H_2O = 7.02 per cent. H.

Nitrogen—Kjeldahl Method I.—.7768 gram substance gave ammonia = 16.75 cc. HCl Sol. (1 cc. = .00822 gr. N) = 17.72 per cent. N.

Dumas' Method II.—.4080 gram dried substance gave 62.36 cc. N, at 15° C. Barometer 762^{mm} at 21° C. = 17.87 per cent.

Sulphur—I. .7841 gram dried substance gave .0463 gram $BaSO_4$=.0064 gram S.=.81 per cent.

II.—.8670 gram dried substance gave .0460 gram $BaSO_4$=.0063 gram S.=.73 per cent.

The fact that this substance separated from warm sodium chloride solutions so readily in the form of spheroids indicated that, under proper conditions, it might be obtained in recognizable crystals. After a very large number of attempts which resulted only in the production of spheroids, a portion of that substance which had deposited on dialyzing the mother liquor from Preparation **20**, was converted into a mixture of spheroids and crystals. The latter were about $\frac{1}{10}$ mm. in their greatest diameters and to all appearance had distinct rhombic faces, but they were not perfectly developed and have not since been observed, many efforts to reproduce them having completely failed.

These crystals were obtained by saturating with the globulin a 10 per cent. sodium chloride solution heated to about 60° C. and allowing it to cool slowly in a large bath of warm water.

After many trials with Preparation **20** a portion of it was completely converted into perfectly formed octahedral crystals which Prof. S. L. Penfield kindly examined and pronounced to be isometric. These crystals were obtained by dissolving some of Preparation **20** in cold distilled water and cautiously adding sodium chloride until a copious precipitate resulted. On immersing the test tube in warm water the precipitate dissolved to a perfectly clear solution. This solution was then allowed to cool slowly in a bath containing about four liters of water heated to 60° C. After 24 hours the deposit was examined under the microscope and found to consist entirely of crystals.

By saturating *distilled water* heated to 60° C. with Preparation **20** and allowing the solution, surrounded by a large volume of warm water to cool slowly, an abundant deposit of octahedral crystals was obtained which were, however, not quite so perfectly developed as those just described.

No analysis of these distinct crystals has as yet been made. Their further investigation will be undertaken directly.

VIII. Methods of Analysis.

Drying.—Preparations preceding **12** were dried in hydrogen at 110° C. to a constant weight. Those following were dried in air at 110° C. Carbon and hydrogen were determined by combustion in a platinum boat in open tube filled with copper oxide and containing in addition a layer of lead chromate and a roll of metallic copper. In the analyses preceding **12** the portions taken for each carbon determination were dried separately to a

constant weight at 110° C. in a stream of hydrogen and weighed in a closed tube. For those following the entire sample was dried to a constant weight in air. By the latter method of drying, slightly higher percentages of hydrogen were obtained when the substance analysed was in the form of a light hygroscopic powder, the dense preparations obtained from alkaline solutions not being so hygroscopic gave slightly lower percentages of hydrogen, the difference is attributable to moisture unavoidably absorbed by the dry, light powder during weighing and transferring to the combustion tube, the analyses being made in very damp summer weather.

The accuracy of the determinations was repeatedly controlled by analyses made on pure sugar.

Nitrogen.—Nitrogen determinations were made both by the Kjeldahl and Dumas methods, in the manner customary in the Station Laboratory.* Preceding **12** the determinations were made upon the substance dried over sulphuric acid, a correction being applied for the moisture contained in the sample as found by drying it at 110° C. Subsequent determinations were made on the fully dried sample.

Sulphur.—Sulphur was determined by fusion with sodium-hydroxide and potassium nitrate, dissolving the fused mass in water, neutralizing the alkali with a considerable excess of hydrochloric acid, evaporating to dryness to decompose nitrates and to remove excess of acid, dissolving the dry residue in six or seven hundred centimeters of water, allowing the solution to stand for 24 hours, filtering, heating to boiling, and precipitating with three cubic centimeters of a 10-per cent. solution of barium chloride.

In the analyses of **8**, evaporation to dryness was omitted, the barium sulphate being fused with sodium carbonate and reprecipitated. In all cases the ash of the preparations was carefully examined for sulphates, but none was found in any instance.

Blank experiments with the reagents proved them to be entirely free from sulphur.

Ash.—Ash was determined by combustion in a platinum crucible, no difficulty being experienced in burning any of the preparations except **18.**

* Annual report of this Station for 1879, p. 124, and American Chemical Journal, vol. 2, p. 27.

IX. Summary of Results.*

1. The proteid body removed from fresh-ground oats by direct extraction with weak alcohol, first observed by Norton and by him designated *glutin*, when dehydrated by absolute alcohol and dried over sulphuric acid is a light yellowish powder, insoluble in pure water as well as in absolute alcohol, soluble in mixtures of alcohol and water, soluble also in dilute acids and alkalies, and from these solutions thrown down by neutralization. Separated from its solution in alcohol of 60 per cent. by evaporating off the alcohol, it forms a yellowish, slimy mass. Its composition (as found for Preparation **8**, p. 12), is given in the table, p. 46, under **I.** This substance is remarkable for its considerable content of sulphur, which is exceeded by that of keratin alone among the proteids, and is otherwise equaled only by that recorded in some analyses of serum-albumin. See pp. 5–14.

2. When the substance described above is heated with dilute alcohol for some time it coagulates and becomes insoluble in that liquid, but without apparent change of composition. **II.**, p. 46, is the average of three accordant analyses of this coagulated form of the alcohol-soluble proteid made on Preparations **7**, **4 A** and **4 B**; pp. 7–12.

Kreusler obtained this material from the oat, but what Ritthausen and he named *oat-gliadin* was a product of its further alteration by the chemical treatment to which it was subjected, with a view to purification. See pp. 4, 13 and 19.

3. When oats are first treated with water or 10-per cent. solution of common salt, before extraction with dilute alcohol, the alcohol-soluble proteid undergoes alteration, and a body of different composition and properties results. In the table, **III.**, is the mean of closely-agreeing analyses of this substance made on Preparations **9**, **10**, **11**, and **12**; it is much more soluble in dilute alcohol than **I.**, and is not coagulated or transformed into an insoluble modification. When wet with absolute alcohol, the moisture attracted from the air shortly renders it gummy and tenaciously adhesive, unlike **I.**

* This Summary is a revision of a part of Bulletin 105, issued by the Connecticut Agricultural Experiment Station, December, 1890, which contained some minor errors that are here corrected.

Its composition, as regards carbon, hydrogen, and nitrogen, is very near to that found by Dumas and Cahours, and also by v. Bibra, for *gliadin* or *plant-gelatin* (extracted by hot alcohol from wheat-gluten and remaining dissolved in the alcohol when cold).

4. The chief proteid extracted by cold 10-per cent. salt solution behaves toward reagents like the *myosin-globulin* from animal muscle, as first stated by Weyl. Contrary to Weyl's observations, however, the coagulation temperature (80°—100°) is much higher than that of animal myosin (55°—60°). This proteid appears to be the result of a transformation similar to that by which myosin is formed from myosinogen. Its composition—the average of several analyses on Preparations **13** and **14**—is given under **IV**, and is very near to that of muscle myosin. The greatest proportion of this proteid extracted by salt-solution from the oat was 1.3 per cent. See pp. 23–28.

5. The proteid extracted, after complete exhaustion of the oats with alcohol of 0.9 sp. gr., by 10-per cent-salt-solution, (analysis of Preparation **15** under **V.**) and that dissolved out by dilute potash, (analysis of Preparation **16** under **V.***a.*), have so nearly the same composition as the globulin extracted by salt-solution directly, that they may be regarded as originally identical, **IV.** representing the soluble form, **V.** and **V.***a.* the insoluble or "albuminate" modification. See pp. 28–32.

6. When ground oats are directly extracted by weak potash-solution without previous treatment with water or dilute alcohol, nearly the whole of the proteids is dissolved. The substance so extracted, after completely removing the body soluble in weak alcohol, is perhaps the same as that first designated *Avenine* by Johnston and Norton, who extracted oats with dilute ammonia-water. Its composition, as indicated by analysis of a single Preparation, **17**, is stated under **VI.**, see also pp. 33 and 36.

7. When ground oats are exposed to the action of water, a large share of the proteids becomes insoluble in dilute potash-solution, the amount so rendered insoluble increasing with the duration of the contact with water. One hour's treatment with water rendered one-half, 24 hours' treatment made two-thirds insoluble in $\frac{2}{10}$ per cent. solution of potash. The composition of the part soluble in potash, after action of water (and removal of the alcohol-soluble proteid), as found in analyses of preparation **18** and **19**, the average of which is stated under **VII.**, is the same as that of the globulin soluble in salt solution, **IV.**

This proteid, obtained by extraction with potash, *after* the action of water, is probably the substance which Kreusler converted into his *Oat-Legumin* by the "purifying" process to which he subjected it. It is also the "protein body" which Norton extracted by weak ammonia and analyzed. See pp. 34–38.

8. When ground oats are extracted with 10 per cent. sodium chloride-solution heated to 65° C. a proteid separates on cooling, in the form of spheroids. This substance differs in composition, and properties from that obtained by cold salt-extraction as well as from all proteids hitherto described. It is soluble in pure water, precipitated from such solutions by a little sodium-chloride, is again dissolved by a certain additional quantity and is precipitated completely by saturation with this salt. In the presence of a little sodium-chloride and acetic acid it is soluble in alcohol of 0.9 sp. gr. From solutions in distilled water, as well as from those in sodium chloride brine, it has been obtained crystallized in regular octahedrons. Analysis (of spheroids) under **VIII.** See pp. 39–41.

9. The aqueous extract of ground oats was found, in agreement with Norton and Kreusler, to contain very little proteid substance. The proteids thus dissolved appear to be, first, an *Acid-albumin;* second, a *Globulin* or *Globulins* similar in reactions to that extracted by 10-per cent.-salt-solution, and third, a *Proteose.* No true albumin was found in the water extract. See pp. 20–23.

10. In the salt-extract a very small amount of a body was found, having the reactions of *Albumin*, but not analyzed. pp. 23–25.

X. Table of Composition of Proteids from the Oat-Kernel.

	I.	II.*	III.*	IV.	V.	V. *a.*	VI.	VII.*	VIII.
Carbon	53.06	53.10	53.70	52.34	52.48	52.45	53.49	52.49	52.22
Hydrogen	6.94	6.91	7.00	7.21	6.94	6.92	7.01	7.10	6.98
Nitrogen	16.38	16.49	15.71	16.88	16.85	16.63	16.39	17.11	17.85
Sulphur	2.26	23.50	1.76	.88	.57	.81	.99	.80	.77
Oxygen	21.38		21.83	22.69	23.16	23.19	22.12	22.50	22.18
		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The numbers over the analyses in the above table correspond with those of the paragraphs in the foregoing summary.

* Average of several analyses.

XI. Key to Table X.

	Extracted by			
I	Alcohol of .9 sp. gr.,	directly,	Soluble,	**8**, pp. 126–127.
II	" "	"	Coagulated,	**7**, etc. pp. 124–125.
III	" "	after water,	Soluble,	**9–12**, pp. 128–132.
IV	Cold 10 p. c. NaCl Sol.,	directly,	Soluble globulin,	**13, 14**, pp. 137–142.
Va	" "	after alcohol,	Albuminate "	**15**, p. 143.
V	1–10 p. c. KOH sol.,	"	" "	**16**, p. 144.
VI	" "	directly,	Initial proteid?	**17**, p. 117.
VII	" "	after water,	Albuminate globulin,	**18, 19**, pp. 148–150.
VIII	hot 10 p. c. NaCl Sol.,	directly,	Soluble spheroids,	**20**, pp. 153–156.

GRASS-GARDENING.

By J. B. Olcott.

"Natural history should be based upon natural facts, and not upon the artificial products of cultivation." *De Candolle*—Origin of Cultivated Plants. London, 1884, p. 409).

The author quoted for the above text was writing of the confusion among names of the cotton plant (*Gossypium*), and advising us to seek with care varieties "which are wild" as a way out of our difficulties.

For the solution of grass-problems this course is even more necessary. De Candolle was right in warning us not to base conclusions upon the "products of cultivation," for Grass-Gardens, at their best, will be but indexes and title-pages of the world at large. Observations confined to them must be no better than reading which stops at the introductions and prefaces of books.

The Grass-Garden lately established at South Manchester had its origin in that at New Haven, as the latter had in the forage of Connecticut and elsewhere; both growing out of the general desire to know more of the grasses we already have and of those the world outside can furnish to our agriculture and gardening.

In laying out the South Manchester grass-garden the Station collection at New Haven was drawn upon for plants or small bits of sod, of the desired grasses, in April, May and at other times during 1890, and also—its soil being excellent for growing and ripening them—for seeds from the collection of pasture-sods made in 1887, and of other sward-producing varieties that had come into its possession by the good will of its friends, purchase, or the accident of being found growing without name and by mistake, from packets of trade-seed.

It may be repeated here, that in the spring of 1887, the writer, as agent of the Station gathered more than six hundred sods —cutting them with a mason's trowel, by the top of a quart strawberry basket—from two or three hundred landed estates

of all sizes, bearing interesting spots and patches of close sward, in Rhode Island and eastern, central or southern Connecticut. This collection was made chiefly with a view to throw light on the *Agrostis* tribe, so that we might know whether it is proper to sell two or more kinds of seed out of the same bag.

Incidentally, varieties of *Festuca* and other genera, that were making turf, or were curious, unknown and promising, were sampled in passing, and the names of the people owning the land entered upon, were attached to the labels of the specimens whenever possible. Hence the seeds saved at the Station from what are there called the "Old State-Sods," had a certain value, as their origin was in some degree *known*.

In the gardens at New Haven and Manchester, the same rule of choosing sods for propagation by their useful performances on the ground somewhere, and in as many places as possible, has been applied with even more determination this year, and with very satisfactory results. In this way we begin with something of history and pedigree. Like does produce like, in grass as assuredly as among cattle, horses and men. Many sods of less than a square-foot, selected about Manchester for their evident turf-making habits and power, cut into fifty or seventy-five pieces and planted in April and May, now each cover completely fifty or seventy-five feet of land. Similar prolific varieties of *Agrostis*, *Festuca* and *Poa* are scattered about the older parts of the old Northern States, as have been seen by the writer, in part within the present year.

Late in May, for instance, Dr. Thomas Meehan of Germantown, Pa., sent to the Manchester garden by mail, from his fifty-years'-old lawn a sod of *Festuca* so small and thin that the postage was but four cents. That grass and six inches depth of the soil it now covers, would over-load a pair of horses. More extraordinary results proceeded from sods sent from a hundred-years'-old meadow by Wm. H. Rhawm, of the Bank of the Republic, Philadelphia.

The soil of the Manchester garden is a brown loam, gravelly and dry at one end of the acre chosen, and liable to be too wet at the other end. It was in stiff turf, manured from the farm and plowed in November, 1889. The part first planted was the site of neglected raspberry-rows, quince-bushes and red-cherry trees; tough ground, full of roots; but as this condition yielded to thorough tillage the land became fairly pleasant for surface work by the time the seed-plats were begun in July. Something more

than half of this acre is now occupied by two hundred and fifty or more plats, four feet square, and by two broad rows of grasses, all in clean cultivation. The remainder lies fallow and ready for another year's transplanting and sowing.

Many of the plats are duplicates to insure against accidents. Some stocks are small because, though valuable, no more seeds or sods were to be had. Stocks of two varieties are larger because of the kindness of a neighbor, Knight D. Cheney, who had them growing and increasing for one or two years in his own garden. This gentleman brought from abroad in July eight samples of the "best" English lawn-grass-seeds, telling the dealer they would be tested here. The seeds looked nicely, yet all but one of the best varieties for sward, (and there was no *Agrostis* among them), were so badly mixed that it is a pity such seeds should be imported free of duty. In each case the foreign seeds were tested and compared by sowing them side by side with seeds of the same kind or, at least, of the same name, saved by Dr. Jenkins or an agent of the Station.

Many tests and experiments are in progress, such as proving the uniformity of growth which springs from the divided product of turf from a single seed; the sowing of such "pedigree" seeds as were to be had, and the transplanting of stocks of sod, believed to be worthy, at different times and especially, late in the season.

How much we generally know about any grass may be judged by the fact that very few are aware that the only variety of *Phleum* we use—and the grass we oftenest sow—is of an amphibious nature and in some places, fairly an aquatic. The past season was too wet for us to assert that we have given any so-called aquatic grasses very severe tests. But we have several under cultivation, and the indications are curious and instructive.

Two door-yards in New Haven (those of Prof. Brewer and Prof. Johnson), have been put under experiment to show that a single variety of grass, well chosen, will shortly cover the ground. It takes some years to make felted turf, but those door-yard trials may be considered successful as far as they have gone. The grasses—a creeping *Agrostis* and a tillering *Festuca*—planted in tufts, or bits of sod, set 12 inches apart, in the middle of April, were not chosen because they were known to be the best, but because they were the only promising ones we had a sufficient stock of for so large plantings at the time. The earth was well enriched and in August the *Agrostis* with fair exposure to sun

had completely hidden the ground, while the *Festuca* sets had grown from less than two to five or six inches in diameter though the yard, with northerly aspect, was much shaded.

It is too early in American grass-gardening to assert or deny many things. But as yet we find no evidence that any variety of grass is pining for alien company and none that a mixture of seeds promotes the growth of any kind. There are plenty of grasses which evidently love to creep in and get what their neighbors are living on. If all flesh is grass, it is a rule which works both ways, for there are graminaceous families that exhibit the selfish and fleshly proclivities of human and animal nature strong enough to attract the attention of moralists. And these appear in gardens not under strict government, now, as they did in "the beginning." Hence, grass-gardens are needed to teach us what to cherish and what to condemn, or keep in check.

But with regard to mixing grass-seeds, look at our chief practices. Indian Corn is our most valuable grass. Do we mix beans or pumpkins with it, or allow weeds to grow in it, to the benefit of the corn-crop? Do we sow any thing with wheat, rye, oats or barley, thinking to increase the yield of grain?

Take timothy—the principal perennial grass we sow—do we mix other things with it to increase the yield of *Phleum?* Does the grower of this hay for market like to see other grasses driving the main one out of his land? No—and all these questions will be answered in the negative. We may choose to mix seeds some times, but we also choose when we can that our seed shall be pure, and that we may know enough to mix it wisely.

It should be remarked, in passing, that our "experiments" with grass are not so experimental as they may appear to those who have paid little or no attention to this particular branch of natural history. We walk by the light or towards it. As the honey-hunter lines the bee-tree with loaded bees, having two points, he reasonably expects to find the third. We place small reliance on strange seeds, but having seen a variety of grass making strong turf against odds, we have a certain confidence in that grass, and proceed to study its behavior under cultivation. Our treatment of it may be mere meddling—a series of blunders—or it may be skillful; therein chiefly lies the experiment; it is partly a test of ourselves. Smooth turf is not a wild but a domestic thing, and with the expert grazier or gardener, a product of careful labor and art. If we think that tough sward

is not a matter of the first agricultural importance, let us consider how the rudest and greediest forms of culture prosper so long as there is plenty of sod to break up and destroy.

In the Manchester garden we used seeds from the "Old State-Sods" which were planted at New Haven so near together, that according to all we know of grass-pollen, the seed might have been mixed and impure. Yet, so far as we can see, by observing the young grasses for this one season of two or three months only, they appear true to their kind and the question may be asked, "Why not rely upon seeds that we may gather from any interesting plants, rather than upon roots for these beginnings of exact culture?"

In reply it may be said that growth from individual seeds of sweet corn from the same cob for instance—grown entirely away from any other variety of maize—is liable, within narrow limits, to vary, and does vary so that nice cultivators take advantage of this fact of variation in changing and improving sweet corn by selection from repeated plantings. Maize in our climate is strictly annual, and we must rely on seeds, but with hardy perennial grass it is better—much better and safer in our opinion—(in these early stages of legitimate grass-gardening), to get the roots of any variety we deem worthy of propagation when we wish to convey to another hand a variety of grass in its integrity. Having a stock of the mother-plants we should prefer not to distribute to other gardens, plants which grew last fall from seeds of the Old State-Sods. In default of older roots of a variety, we shall do our best with the produce of seeds that from their liability to vary need more tests and longer watching.

Seeds so small as grass-seeds will trouble a beginner to distinguish them and keep them free from weeds and especially from other grasses in the first weeks of their sprouting and growth. But roots are more tangible. They grow quicker and begin to teach us the difference in grasses as soon as we unpack them from paraffine paper and moss and read their labels.

The transportation of roots is more troublesome than that of seeds, but they may safely go long distances in cool weather, many kinds in a box. Two distinct sods, shipped us by Hon. Augustine Heard, U. S. Consul at Seoul, Corea, reached us alive, as we are going to press, and in hopeful condition for propagation, with due care.

There will certainly be several varieties of grass-gardening. A farmer and grazier, intent on something he can use and perhaps grow seed of for sale, will choose a few kinds of sods which seem most promising, cut them in pieces and plant them in rows in different places. Or at first he may prefer to plant a row of forty or fifty named sorts in bits of sods, in his garden, for the edification of himself, his family and his friends. This should be no more trouble the first season, than rows of strawberries of the same length.

A gardener, desirous of improving dooryards and lawns, will select varieties of grass with finer textures and curious colors, and if he sees, as many gardeners do, that we spend money freely for fanciful and beautiful things, he will prepare himself to plant or sow lawns in tasteful mosaics and arabesque patterns, as our grandmothers pieced bed-quilts and wove counterpanes.

Superintendents of city and village parks, wishing to learn what good sward can be composed of and to show their cultivated patrons how the grasses, that we all live by, appear separately, and to teach ruder people that there are wild things worth hunting, besides rabbits under farmer's stone walls, might do worse than to copy the plant at Manchester with modifications to fit local tastes. There is not the least necessity for testing or exhibiting grasses by growth in rectangular patterns. They can be made to fit any shape, like silk, or cotton goods.

State grass-gardens may and should lead in testing and introducing the best native and foreign varieties, unless enterprising seedsmen, heartily ashamed of our present ignoble predicament as regards seeds, should combine to go ahead of us all in radical demonstrations of what can be done with this oldest, most promising and best-neglected industry.

To see whether it is possible for an agent of the Station to plant a small grass-garden on the land of unofficial parties, and trust the care of the same to its owners, as we do plantings of corn, potatoes, etc., a test was made in the garden of the Misses Gilman of Norwich Town. Twenty-three small plats of divided sod were planted June 14th. These were given perfectly clean tillage, and but a single plant was lost. In September, more than that number of plats, of sod or seed, were planted or sown. That fresh interest in grass-growing, and a more exact knowledge of the varieties we do or may cultivate, must spring from a little center of that kind is as obvious as it is true. Similar institutions of learning ought to be established throughout the State.

In like manner, on a larger scale, with more trouble and expense, not borne by this Station, its agent was enabled to co-operate with the Station of another State and a collection of grasses was well begun at State College, Center County, Pennsylvania. It is believed by those who have thought much about it, that the evils of mixed grass-seeds and mixed grass-names can be abated in a reasonable time, by the cultivation of the best varieties in gardens, with the coöperation of Experiment Stations.

Our plan for multiplied observations of precisely the same grasses, by the distribution and exchange of sods, and their growth in widely separated public and private gardens, is the shortest way out of the fog which envelops us. Testing seeds, as now gathered from all manner of uncertain or unknown sources, only adds to the muddle of names and varieties. When books don't agree, and writers are uncertain, we have a right to go to the plants themselves, separate them, compare them, and save seed from the best. Isolated States cannot prosecute this great business to advantage alone, against contrary opinions pouring in upon them. There must be close and exact coöperation.

Other Stations have given their adhesion to the methods practised in Connecticut, and there are indications of popularity in the movement towards better turf-grasses. Farmers and gardeners, who are judges of old and new things, with a desire to prove all, and hold fast that which is good, will govern themselves accordingly.

The plats at Manchester were marked for sod-planting with a light ten-barred frame of three-inch slats, crossing each other, through which six-inch . . . . . wire-spikes were driven half-way, and cut off, ... so the projecting heads would imprint mellow . . . . . earth as here shown. Round pine rods $\frac{3}{4}$ inch . . . . . diameter might serve as well as the wire-spikes. . . . . As the frame is exactly four feet square outside, the plant-centers, twenty-five in number, are not quite 12 inches apart.

For the seed-sowing, was used a frame four feet square *inside* made of $1\frac{1}{4}$ inch pine-plank, six inches wide, halved together at the corners, and fastened with wire nails and screws. This was very convenient to stand upon while sowing the seed and covering it with fine earth. The edges of the young grass came up neat and square, as in a miniature field. The handsomest plats in the Man

chester garden can be repeated by the acre, without extraordinary expense, when we have sods or seeds enough.

These frames are as large as one person can handle, and may be recommended for the general purposes of large testing and propagating gardens.

The seed-frame has two inch-square notches at its middle, inside and opposite each other, to receive the two one-foot pegs of squared and pointed ⅞ pine, which are driven in line, at alternate distances of two and four feet, to mark the exact places of plats. The sod-frame, when in use, can be ranged by its center slat on these pegs, fitting between the pairs of them, which also mark the two-feet alley-spaces, and are handy to knock clogged weeding tools upon in wet weather. A smooth bit of plank, weighing ten or twelve pounds, and 12×15 inches square with an upright handle, to firm the soil; together with a sixteen-foot pole, with notches, to gauge distances between the aforesaid pegs, in driving them by the line; complete the list of special tools for plat-seeding or planting.

The tillage and weeding at Manchester was a rather serious affair, at first, and it would not be advisable for any one to undertake such ground as that was, unless fully aware of the difficulty of governing it. But the thrift of the grasses, both planted and sown, on that tough sod-land, was very gratifying.

Four hundred pounds of a good commercial fertilizer were used on the part of the land now in grass, because, presumably, the upturned soil, in the clutch of roots, would not be very fertile at first, and that the farm manure beneath the sod would be inoperative at the surface early in the season. The cause of certain faded spots in the grass and of its short growth in those places is not known at this writing. That matter has long called for investigation.

Serviceable plats for the comparative culture of grasses can be planted and sown of any size we please. The smaller they are the less our experiments will cost, especially if we have weedy land. A good plan for beginning a grass-garden is to prepare sod-land the season before we need it, as the fathers prepared ground for flax and other crops.

For the weeds at Manchester special tools had to be contrived and made, or the garden would have been an ignominious failure, only fit for the plow. This feature of the undertaking had been thought of for years, however, and these tools were illustrated in

the May, October and November numbers of the *American Garden* for 1890. Some of them are being manufactured to order by Smith Harper, Fox-Chase, near Philadelphia.

Because of the general inattention to varieties, hitherto, in this country, no varietal names are known for many sorts of *Agrostis*, *Festuca* and *Poa*. By their record and history several of these grasses, evidently prolific and fixed in type, must be very valuable. How can this value be realized? By propagating each, after its kind, from roots, slips or cuttings, and seeds—operations quite as easy when once well learned, as the increase of corn and potatoes. There is material at Manchester to start a hundred similar grass-gardens.

Another element of value consists in the fact that these garden grasses have become as nearly *pure* as possible in the time spent upon them. Except one variety (*Poa annua*), nothing has been allowed to go to seed, in the Manchester experiments. When many sorts of seed are allowed to scatter, the difficulties of grass-gardening are enormously increased, and the purity of the collection will be lost or placed in jeopardy. No instance of crossing between varieties, has been observed by recent Connecticut experimenters; but the nature of the subject demands extreme caution, since the chances are practically unknown.

Success at New Haven and Manchester, in the selection of varieties distinctly useful, must lead observers and reasoners to inquire: If these valuables can be picked up in a country where the conditions that produce domestic sward are comparatively new, what shall we find, under sward-making conditions, where cultivation is thousands of years older?

No farmer or grazier can examine these grass-gardens, even as late as Nov. 16th, the date of this writing, without being disturbed in his mind as to whether he has yet enjoyed the use and profit of the best grasses. So far as the useful grasses of the world are involved, our collections should be made complete as soon as possible, lest more labor and time be lost in propagating inferior varieties.

The beginner, in collecting valuable varieties of grass from the short sward of door-yards, pastures and meadows will need more instruction than can be given here; and attentive observation, while walking at leisure, will help vastly in illustrating the few words that may be ventured in a matter which requires, most of all, an experienced eye. The rather common impression

that all spots in turf come from unequal fertility, is mistaken. The droppings of animals do make many distinct spots, in pastures and meadows, no doubt, greatly changing the color and fiber of grasses. The learner must have practice enough to distinguish these appearances, and may find it easier to read the sward where no animals have been—as in door-yards, parks and lawns. There the gray or blue-green and sharply pointed leaves of some form of *Agrostis*, may be the first to attract attention. O · the shining spears of a *Poa*, a *Festuca* or a *Lolium*, may quickest take the eye. The identification of any one prevalent grass, wherever it occurs—like deciphering the prevailing letter in secret writing for a clue—will help greatly in distinguishing the rest. As we learn to know people at sight, without formal introduction, so we may recognize perfectly a number of grasses, when we have met them times enough, without knowing their names. Prof. McAlpine's work "How to Know Grasses by the Leaves" (David Douglas, Edinburgh, 92 pages, illustrated, price, 3 shillings 6 pence), will greatly assist those who know how to use good books to begin with. But to select turf that is worthy of propagation, requires keen sense of color and form, and will utilize all the practice possible to the farmer, gardener, and grazier. The acutest assistant at Manchester—Mr. Eli Risley—is a specialist in neither of these directions, however; but a veteran cassimere maker. His long experience with all manner of woolen fabrics, combined with his trained eye for colors, made him a practical connoisseur in turf fabrication almost at once. We have thousands of ingenious and cultivated people, who may become equally skillful, when their attention is turned to the matter, greatly to the advantage of Agriculture and Gardening.

As the skilled physician diagnoses disease or health, in part, by the skin of his patients, so the expert grazier or farmer always judges the condition of land by the appearance of its turfy integument; and often recognizes, by spots of this, that, or the other grass in the sward, the waning or increasing fertility of fields. And whether one becomes expert in knowing grasses by their leaves, roots, color, taste, feel, habits and habitats or not, the least training of the eye and judgment in these directions cannot fail of being useful to those who would govern the land. The best season for collecting sward-grasses is early in spring or late in fall or during open winters, while annual vegetation is dead.

What are called the "Pasture Plats" at the New Haven Station were laid down with the idea of having many known kinds of grass that could be cared for and observed through a number of years for grazing at will. The pasture-plats were planted a year ago last October. Sixty-four plats, with three or four exceptions, all of grasses and clovers, were set in the common sward of the Station (much improved of late years by broad-cast manuring and the grazing of cows well-fed in the stable) where they are distributed over a space sixty feet square. The ground of the plats was thoroughly dug fifteen inches deep, and fertilized as it should have been for planting a shrub or a small tree. In most instances, the roots or turf of the desired plants were set in place, flush with the general surface, and as closely as the stock in hand would allow. This method was chosen to make plats that would endure, as soon as possible, the treading of the two cows at the Station. The greater part of these plats were filled from the Station Forage Garden. The stock for five of them was sent in one barrel from South Windsor, East Hartford and Manchester. The material for as many more plats, perhaps, was picked up in the vicinity of New Haven. Weedy and mixed sods require persistent care to purify them. *Juncus Gerardi* (black grass), and *Spartina cynosuroides* (cord grass), were taken from the salt marshes. There is a plat of *Achillea millefolium* (yarrow), said to be a valuable forage-plant by English writers, whose seedsmen put *Plantago lanceolata* (narrow-leafed plantain), in their catalogues. The last-named weed was already in the four-feet wide alleys of the old pasture that surrounded each plat. There are many kinds of vegetation that domestic animals will eat at one time or another, but the burning questions are: How many of these need we take the pains to cultivate? How many ought to be allowed in trade seed-mixtures? The presence of a plant in the neglected pastures, is not sufficient proof that it is good husbandry to sow it anywhere. The absence of a plant from long-used pasturage may be evidence that we have allowed domestic animals to love it, not wisely but too well.

One of those pasture-plats was set with the roots of *Equisetum arvense* (horse tail), and it is thriving. This very persistent rush is said to injure horned cattle and *not* horses, in Germany, while in New England we hear that it kills horses, but other animals may eat it with impunity. Thousands of acres of the best natural meadow in Connecticut produce more or less of this plant,

which tastes very like some excellent grasses. Hundreds of tons of it are fed to our animals. Hence, as we know very little accurately about it, while many people fear it, and no one probably cares to see it in his land, *Equisetum arvense* becomes a legitimate subject for inquiry.

Other plats bring other forage-plants into strong contrast. *Carex vulgaris* (cut-grass), grows very near *Poa arachnifera* (Texas blue grass). The *Agropyrum repens* (quack grass) is not far from *Agropyrum glaucum*, which the cattle and horses of western ranges are said to be very fond of.

Eight frames made of six-inch chestnut fence-boards, covered with wire-netting, like quail-traps, were provided to protect any of these plats from too much grazing while they are in a state of probation; or while any of them are being renewed or changed by sowing or planting with other kinds of forage, which it is desirable to test by grazing, etc., or to put under surveillance.

Early last May, when some twenty-five or thirty of these plats had made a luxuriant growth of three to eight or twelve inches, according to their various natural statures; and while the white clover and "blue-grass" of the alleys was half-leg deep, the cows, that had been a week or two in pasture similar to that of the alleys, were turned in for three days in succession.

Several sets of notes were made at the Station upon this occasion, more for the sake of fixing our minds upon it than for publication. The patent fact was that those two cows reached entirely over the lush feed, they were used to, in the alleys, and licked out the strange plats which were in season, clean to the blanched stubble and roots, like the bottoms of so many meal-tubs. Evidently milch cows appreciate a variety of food quite as well as we do.

A veteran observer remarked that, "When dairymen and farmers get their eyes open to 'grass' they will be growing it pure, in five and ten-acre lots for the sake of variety." This would be reasonable for fodder as well as for seed. To make milk, and beef plenty and good, cattle must EAT, and it is evident that the proper variety of fodder will tempt them to eat and keep them in health while they are consuming and producing their utmost.

After the three days of grazing the pasture-plats had a long rest, and some nursing. It is not good farming to graze pastures closely that are less than a year old. Twice afterwards, at intervals the cows were let in; once when all the plats were as tough

and dry as they could well get during a wet August, and only the lawn-mowed alleys were succulent; but Daisy and Nancy proved themselves excellent judges of fodder. They used the tall wiry grass of some plats like pasture bushes to knock the flies off, and showed their preference for fresh vegetation every time.

Whether public opinion should require every agricultural experiment station, school, or society to devote so much as sixty square feet of land to grass-tests of a like character, may be a question. That such a requisition would tend to purge our literature of grass-mistakes, and our farms of weeds, by bringing sheep and cattle back, with the common consent of the butcher, the wool-manufacturer, village dog and politician, there is no doubt whatever.

A certain proportion both of sward and of forest is needed for public safety. The American States have immense areas of ruined woods and wasted sod to make good. A careful and systematic study of the best methods for their renovation is most appropriate work for our Experiment Stations.

FEEDING STUFFS.

Here follow such analyses of Feeding Stuffs as are not discussed elsewhere in connection with field experiments. For explanations regarding the nature and uses of the separate food ingredients, the compounding of rations, "feeding standards," etc., reference may be had to earlier Reports of this Station, in particular the one for the year 1886.

Cotton Seed Meal.

2980. "Sea Island Meal." An undecorticated meal having a reddish-brown color. Sampled and sent by Messrs. Meech and Stoddard, from stock purchased of Butler, Breed & Co., of Boston. The fertilizing ingredients of this sample have been already given on page 25.

3073. "Sea Island Meal." Sampled and sent by F. M. Bartholomew, East Wallingford, from stock bought in New Haven, at $25.00 per ton.

3105. "Cotton Seed Bran." Sampled and sent by Horace Burr, Winchester. This sample in appearance and composition is not very different from the two samples of Sea Island Meal just mentioned.

3006. Purchased of R. H. Ensign, Simsbury, for $27.00 per ton.

3009. Purchased of J. and H. Woodford, Avon, for $27.00 per ton. The last two samples were drawn and sent by S. S. Stockwell, Sec'y Advance Grange, No. 22.

3106. From stock purchased and sampled by Horace Burr, Winchester.

Analyses—*As received.*

	2980	3073	3105	3006	3009	3106
Water	11.12	8.60	10.03	10.46	8.29	8.09
Ash	4.69	4.87	4.92	7.07	7.85	7.20
Albuminoids *	22.93	25.50	24.13	40.88	42.31	40.13
Fiber	17.48	17.65	21.39	7.53	3.78	8.53
Nitrogen-free extract	36.11	35.12	34.06	25.18	24.13	27.69
Fat	7.67	8.26	5.47	8.88	13.64	8.36
	100.00	100.00	100.00	100.00	100.00	100.00

* Total Nitrogen × 6.25.

Water-free.

	2980	3073	3105	3006	3009	3106
Ash	5.3	5.3	5.4	7.9	8.5	7.9
Albuminoids	25.8	27.7	26.8	45.7	46.1	43.7
Fiber	19.7	19.2	23.7	8.4	4.1	9.3
Nitrogen-free extract	40.7	38.8	38.0	28.0	26.3	30.0
Fat	8.5	9.0	6.1	19.0	14.9	9.1
	100.0	100.0	100.0	100.0	100.0	100.0

The last three samples are decorticated meal of usual quality. Nos. 2980, 3073 and 3105 are strikingly different in appearance, quality and feeding value. The low per cent. of albuminoids and the lower manurial value are due to the presence of hulls which are greatly inferior to the kernels in respect of the ingredients named. Undecorticated meal is fed at the South with good results, but the undecorticated meal at $25.00 is not nearly so economical as the decorticated meal at $27.00 per ton.

A statement of the fertilizing ingredients in two of the above samples and a valuation per ton *as fertilizers* follow. In the valuation nitrogen is reckoned at 15 cents, phosphoric acid at 7 cents, and potash at 6 cents per pound.

	2980	3006
Nitrogen	3.67	6.54
Phosphoric Acid	1.60	3.03
Potash	1.45	1.79
Valuation per ton	$14.99	$27.56

Linseed or Oil-Cake Meal.

2981. Steam-cooked Cleveland Oil-cake Meal.
2982. " " " Fine Linseed Meal.
3003. " " " Coarse Linseed Meal.

Sampled and sent by the Cleveland Linseed Oil Co., Cleveland, Ohio.

2662. Cleveland Linseed Meal, sent by J. W. Yale, Meriden.

2663. Old process Linseed Meal, bought of Mann Bros. & Co., Buffalo, N. Y., by J. W. Yale, Meriden.

3063. Old Process Linseed Meal, sampled and sent by Chas. M. Cox & Co., 10 Broad St., Boston, Mass.

ANALYSES.

	2981	2982	3003	2662	2663	3063
Water	12.52	12.79	12.45	9.60	12.76	9.48
Ash	6.05	5.44	5.96	5.53	5.59	5.40
Albuminoids (N. × 6.25)	31.81	35.69	37.81	37.11	32.75	37.56
Fiber	7.63	7.62	7.71	8.04	6.83	7.75
Nitrogen-free extract	35.34	35.33	33.94	37.09	33.01	32.95
Fat	6.65	3 13	2.13	2.63	9.06	6.86
	100.00	100.00	100.00	100.00	100.00	100.00

Water-free.

Ash	6.9	6.2	6.8	6.0	6.4	6.0
Albuminoids	36.3	40.9	43.2	41.1	37.5	41.5
Fiber	8.7	8.7	8.8	9.1	7.8	8.5
Nitrogen-free extract	40.5	40.6	38.8	40.9	37.9	36.5
Fat	7.6	3.6	2.4	2.9	10.4	7.5
	100.0	100.0	100.0	100.0	100.0	100.0

The manurial ingredients were determined in several of these samples, as follows:—

	2981	2982	3003
Nitrogen	5.09	5.71	6.05
Phosphoric acid	1.59	1.79	2.12
Potash	1.30	1.37	1.47
"Valuation"*	$19.06	$21.28	$22.88

* Nitrogen 15 cents, phosphoric acid 7 cents, and potash 6 cents per pound.

Next to Cotton Seed Meal, Linseed Meal carries a larger quantity of fertilizing ingredients per ton than any other commonly used feed. Like cotton seed it is sometimes used as a fertilizer.

MISCELLANEOUS FEEDS.

3007. Malt Sprouts. Stock of J. & H. Woodford, Avon. Sampled and sent by S. T. Stockwell, Sec'y, Advance Grange, West Simsbury.

3056. Brewers' Grains from Quinnipiac beer brewery.

3057. Brewers' Grains from ale brewery.

3068. Brewers' Grains from Weibel's beer brewery. Sampled by Station Agent.

3053. Middlings. Sent by H. P. Morse, So. Canaan. Suspected of adulteration.

3008. Corn and Oat Feed. Bought of J. & H. Woodford, Avon. Sampled and sent by S. T. Stockwell as above.

3101. Buffalo Sugar Feed. Bought by J. H. Webb, Hamden. Sampled by Station Agent.

ANALYSES.

	3007	3056	3057	3068	3058	3008	3101
Water	12.25	76.02	78.36	76.81	12.63	11.23	11.40
Ash	5.97	.90	.86	1.25	4.97	4.64	1.05
Albuminoids	26.13	5.78	4.20	5.75	16.62	7.00	22.06
Fiber	10.37	3.46	3.83	3.36	7.57	11.53	5.13
Nitrogen-free extract	44.20	12.37	11.33	11.57	54.54	62.68	51.13
Fat	1.08	1.47	1.42	1.26	3.67	2.92	9.23
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Cost per ton	$18.00	$3.33	$3.33	$3.33		$24.00	$25.00

Water-free.

Ash	6.8	3.8	4.0	5.4	5.7	5.2	1.2
Albuminoids	29.8	24.1	19.5	24.8	19.0	7.9	24.9
Fiber	11.8	14.4	17.7	14.4	8.7	13.0	5.8
Nitrogen-free extract	50.3	51.6	52.2	49.9	62.4	70.6	57.7
Fat	1.3	6.1	6.6	5.5	4.2	3.3	10.4
	100.0	100.0	100.0	100.0	100 0	100.0	100.0

The "Corn and Oat Feed" sample No. 3008, is a much less concentrated feed than either sound corn or sound oats, or any mixture of the two could be if the whole grain was used. This will be clear if we compare the composition of the three.

	Maize kernel. 211 analyses.	Oats. 27 analyses.	"Corn and oat feed."	Hay from mixed meadow grasses.
Water	10.9	11.0	11.23	14.5
Ash	1.5	3.1	4 64	5.1
Albuminoids	10.5	11.5	7.00	7.3
Fiber	2.0	9.8	11.53	29.1
Nitrogen-free extract	69.7	59.8	62.68	41.7
Fat	5.4	4.8	2.92	2.3
	100.0	100.0	100.00	100.0

The "Feed" contains much less albuminoids and fat than either oats or maize, and much more fiber and ash. It is probably a mixture of maize and inferior oats and chaff, or of clippings from oats. It has less albuminoids than good hay even though probably a larger percentage of digestible albuminoids.

There is no security in the purchase of mixed feeds. They are a sort of "dumping ground" for light seed, screenings and all kinds of mill-refuse.

No. **3053,** Wheat Middlings, bears no evidence of adulteration and is of fair quality as far as can be learned from the analysis.

Maize Kernels, Field-cured and Ensilaged.

Mr. D. H. Van Hoosear sent to the Station two ears of maize. One taken from the silo Dec. 22, the other field-cured, with the inquiry whether there had been a loss of any ingredients in the silo. Not knowing the original weight of the maize, the only point that could be ascertained was whether the samples differed widely in the composition of their dry matter.

The analyses follow :

Analyses.

	As received.		Water-free.	
	From silo.	Field-cured.	From silo.	Field-cured.
Water	40 47	13.92	----	----
Ash	.74	1.26	1.25	1.47
Albuminoids	6.90	10.03	11.59	11.64
Fiber	1.56	1.53	2.63	1.78
Nitrogen-free extract	47.38	69.08	79.57	80.24
Fat	2.95	4.18	4.96	4.87
	100.00	100.00	100.00	100.00

It is seen that the composition of the dry matter of these two samples is practically identical, and the analyses go to show that there has been no material change in the composition of the kernels in the silo.

This accords with the results of elaborate investigations made elsewhere on the same subject. The well-managed silo excludes air from the forage and impregnates it with powerful and harmless antiseptics, carbonic and other acids. These acids are products of fermentative change and are mainly formed out of the sugar in the broken and juicy parts of the ensilaged crop. The seeds of unhusked maize would naturally be little involved in this temporary fermentation, which is soon arrested by the acids developed in its progress, and occasions no more loss of nutritive substance than accompanies curing in the field.

Salt Herrings as Cattle Food.

Early in 1891, Mr. Maltby Gelston of East Haddam, sent to this Station a sample of alewives or herring with the following interesting account of his experience with them as a food for stock.

"I have fed the fish for the past three years. Three years ago last July I had a part of a barrel of alewives left over; not having enough to fill it I could not ship it to New York with my spring catch. Remembering that years ago when shad were plenty, if our cows went wrong at calving, we used to give as a remedy, the tails of these fish with good results, it occurred to me that alewives would answer the same purpose. This thought led to others. I remember that the largest sheep I ever saw, and one whose usual clip was about 16 pounds, was a cosset that fed near our fish place, and frequently used to steal our fresh shad as they lay on the banks of the river and eat them. This was sixty years ago, when I was a boy. I concluded to try salt alewives on my cows, and accordingly gave each of them a fish. Some of them would at first only lick them, while others would eat them at once. By degrees all of them began to like them exceedingly, since then I have fed them regularly during the winter, from three to six salt alewives each, once or twice a week. When I give them the fish I withhold their ration of grain. I give them the fish in the morning, that they may have free access to water should they want it. We have noted no effect either in the flow or flavor of the milk, but find the cows greatly improved in condition.

For poultry, we soak the fish till quite fresh, boil them and mix with meal or boiled potatoes, say about equal weight of each. We have now forty-one hens and five geese to which we give, every other morning, seven fish thus boiled and mixed. The poultry eat every bone and scale. The result is good.

These fish are caught in the spring in all rivers emptying into the ocean between Cape Hatteras and Nova Scotia. They can be bought at the fish place, same as samples, in bulk, at from $30.00 to $35.00 per ton.

Hayti and St. Domingo have been our market for them since the war of the Rebellion, for which market they usually bring about $4.00 per barrel of 200 lbs., delivered in New York. Previous to our late war the Slave States bought them at about the same price. The additional expense of fitting them for and

placing them on the market as food for man, together with commissions for selling, would make $30.00 per ton at the fish place as remunerative to the fishermen as the price obtained in the foreign markets. Query: Are they worth $30.00 per ton for feed for stock, with cereals or hay at the present prices"?

The fish as received were quite wet and very tender, easily breaking to pieces. A dozen of them weighed four pounds and fifteen ounces. Their composition was as follows:

	Undried.	Water-free.
Water	52.94	----
Salt	15.33	30.58
Other mineral matter*	3.58	9.59
Albuminoids †	18.10	38.46
Nitrogen-free extract	.85	1.81
Fat	9.20	19.56
	100.00	100.00
*Containing phosphoric acid	1.84	3.89
†Containing nitrogen	2.90	6.15

These salt fish contain more albuminoids, usually the most costly ingredient of feeds, than hay or any of the cereal grains. They contain one or two per cent. more of albuminoids than wheat bran, and two and a half times as much fat, but practically no other non-nitrogenous matter.

Fish suitably prepared is a valuable cattle food, and is regularly used for that purpose in some places, and for milch cows as well as other cattle.

The quantity of salt present in this sample would limit the feeding of it. Half a dozen alewives like those analyzed contain six ounces of salt, which is too much for an every-day ration. That number of herring would supply as much digestible albuminoids and two or three times as much digestible fat as three pounds of wheat bran. There is no reason why, fed after Mr. Gelston's method, they should not be a valuable addition to the winter feed of live stock.

Finely ground fish scrap as well as dried blood in the shape in which they are now offered in our markets are worth cautious and intelligent trial as food for stock. Their use would be to supply a concentrated nitrogenous product comparatively poor in non-nitrogenous matter to balance rations which in the great majority of cases are deficient in albuminoids.

On the Market Prices of the Ingredients of Feeding Stuffs.

The present market quotations of concentrated feeds and mill-products show a peculiar condition of things regarding the actual cost of albuminoids, fat, and carbhydrates (including fiber).

Cotton seed meal, which is the most concentrated feed in market, richest in both albuminoids and fat, has remained for the last few years quite constant in price. Linseed meal, which is also rich in albuminoids, has fallen decidedly within two years. The average price in January, 1888, was $32.25 for old process meal, and at the same date in 1890, $28.00. But on the other hand the corn and wheat feeds and by-products, which are relatively poor in albuminoids but rich in carbhydrates, some of them also in fat, have risen greatly in price, from 20 to 25 per cent.

It thus happens that in our ordinary mill feeds carbhydrates cost as much as albuminoids, as is seen in the following comparative statement of the average cost of food ingredients in fine mill feeds for the years 1888 and 1890:

	In 1888.	In 1890.
Albuminoids (N. × 6.25)	1.6 cents per pound.	1.4 cents per pound.
Fat	4.2 " "	2.9 " "
Carbhydrates (including fiber)	.96 " "	1.4 " "

Now while the carbhydrates take nothing from the land at harvest and add nothing as a fertilizer in the manure, every sixteen pounds of albuminoids harvested from the land carry with them a pound of nitrogen. And so too every sixteen pounds of albuminoids fed to cattle add a pound of nitrogen to the manure—less the amount withdrawn in the flesh or milk, which latter may be estimated at somewhere near half a pound of nitrogen to 40 quarts of milk.

It is true at any time that a generous and comparatively concentrated feed is the most economical; but, in view of the facts just cited, it is urged that feeders should give special care to their feeding, in order to have no waste of carbhydrates and to feed an excess of albuminoids, which enrich the manure, rather than an excess of carbhydrates, which have no manurial value.

Cotton seed and linseed meal, gluten meal, malt-sprouts, and brewers' grains seem at present to be the most economical of our concentrated feeds.

THE COMPARATIVE EFFECTS OF PLANTING IN HILLS AND DRILLS ON THE QUANTITY AND QUALITY OF THE MAIZE CROP.

Aside from the alleged advantage of cross-cultivation which is made possible by planting in hills the claim is frequently made that on an acre of land a given number of stalks standing in hills will, other things being equal, yield more than the same number of stalks planted in drills. The reasons given are in general that stalks in hills mutually support each other, that the ground is not so completely shaded by the crop and in consequence is warmer and air also circulates more freely when the planting is in hills.

When the stalks stand at a uniform and reasonable distance in the drill there would seem to be opportunity for all necessary circulation of air, and the more evenly plants are arranged in a field the more even will be the distribution of light among them, provided they stand close enough to secure the maximum yield and so to shade each other very considerably. What is gained by one plant in a hill in the way of exposure to light must be lost to another. That certain spots on the soil might be warmer when maize is planted in hills may be granted, but that the mass of the surface soil is made warmer by this means seems doubtful, as does the advantage of one method of planting over the other in the way of mutual protection by the stalks in heavy storms.

The following experiment was undertaken as a contribution to the discussion of the question.

The land used was the same as that described on pages 10 and 219 of the Report of this Station for 1889, where the history of the land is given and all details as to previous crops, fertilizers etc. It is the same as represented on page 12 of that Report, plots A to L. In 1889, plots A to F were fertilized and planted precisely like the corresponding plots from G to L as described on page 219 of the Report for 1889.

Arrangement of the Field.

The accompanying diagram page 184 will make clear the arrangement of the field and its division into strips and plots. The two strips of the previous years, running from A to F and

from G to L respectively and containing six-tenths of an acre each, were in 1890, divided as in the figure, making *four* strips running north and south each containing three-tenths of an acre and divided into six plots A_1, B_1, etc. Each plot therefore in 1890, contained $\frac{1}{20}$ of an acre.

ARRANGEMENT OF THE FIELD.

Each strip is divided into 6 plots of equal size and an area of $\frac{1}{20}$ acre. The strip running north and south from A_1 to F_1 received cow manure, A_2 to F_2 hog manure. G_1 to L_1 received mixed chemicals and G_2 to L_2 no fertilizer.

NORTH.

F_1	F_2	L_1	L_2
E_1	E_2	K_1	K_2
D_1	D_2	J_1	J_2
C_1	C_2	I_1	I_2
B_1	B_2	H_1	H_2
A_1	A_2	G_1	G_2

SOUTH.

The same variety of maize had been raised on this land for two years previous to this experiment. The fertilizers applied and the crops harvested were both accurately weighed and analyzed and the exhaustion or enrichment of the soil calculated. The total quantities of nitrogen, phosphoric acid and potash per acre applied in the fertilizer and removed by the crops of 1888 and 1889, were as follows :

	Nitrogen.	Phosphoric acid.	Potash.
Put on in the fertilizer	90.2	214.4	155.6
Taken off in the crop	152.0	69.8	95.8
Gained, [+], or lost, [−] by the soil.	−61.8	+144.6	+59.8

A yield of 100 bushels of shelled corn per acre in 1890 would take from the soil 109 pounds of nitrogen, 47.8 of phosphoric acid and 70.5 of potash. The intention therefore was to apply nitrogen at the rate of 171 pounds per acre in order to make up for past deficiencies in the fertilizer and give a very liberal dressing for the coming season.

The strips A_1 to F_1, received 20,925 pounds or 3.2 cords of cow manure which is at the rate of 10.7 cords per acre.

The strips A_2 to F_2, received 21,141 pounds or 4 cords of hog manure which is at the rate of 13.3 cords per acre.

The strip G_1 to L_1, received a mixture of chemicals consisting of 100 pounds of nitrate of soda, 80 pounds of sulphate of ammonia, 80 pounds of dried blood, 125 pounds of cotton seed meal, 90 pounds dissolved bone black, and 40 pounds of muriate of potash which is at the rate of 1700 pounds per acre.

The strip G_2 to L_2 received no fertilizers. The analyses of the samples of manure are given on page 71, of this Report. The quantities of nitrogen, phosphoric acid, and potash in these several applications are as follows :

	Nitrogen.	Phosphoric acid.	Potash.
Strip A_1 to F_1, three-tenths of an acre	87.9	42.7	62.7
" A_2 to F_2, " " " "	122.6	170.8	21.6
" G_1 to L_1, " " " "	51.5	48.6	20.8
" G_2 to L_2, " " " "	----	----	----

The manure was plowed in. The commercial fertilizer was sowed by machine after plowing and was harrowed in.

Planting.

The rows of hills and drills were alike four feet apart. On the following plots the maize was planted in drills, the stalks to stand 10 inches apart, A_1, C_1, E_1, A_2, C_2, E_2, G_1, I_1, K_1, G_2, I_2, K_2.

On the following plots the planting was in hills 40 inches apart, stalks to stand four in a hill, B_1, B_2, H_1, H_2.

On the following plots the planting was in hills 30 inches apart, stalks to stand three in a hill, D_1, D_2, J_1, J_2.

On the following plots the planting was in hills 20 inches apart, stalks to stand two in a hill, F_1, F_2, L_1, L_2.

The planting was done May 29th by members of the Station staff with great care, dropping the seed by measuring line. Excess of seed was used to insure a full stand and when the plants were five inches high they were thinned so that the drills averaged exactly one stalk in ten inches and the variations from that distance were in all cases very small.

This arrangement of the field and fertilizers makes possible a comparison of the relative effects of planting in hills and drills on plots quite different as far as manuring goes but otherwise believed to be quite uniform in quality.

Cultivation and Notes during Growth.

The plots were all cultivated at the same time and in precisely the same way. The season was a very favorable one and the crop grew and ripened without any serious accident. Two weeks before cutting, the corn was badly beaten down by storms but it did not lie on the ground to any serious extent and ripened off well. No difference in lodging could be observed on the different strips or between the hills and drills. The following notes were made :

July 8. The maize growing on the hog manure is decidedly the tallest in the field, thicker at the butt and darker in color. Next in thriftiness appears to be that which was dressed with cow manure. The strip which received fertilizer chemicals and the one that received no fertilizer look precisely alike and are much inferior in development to the other two. The color of the foliage is paler.

There is a spot of backward, spindling growth on the north end of G_1, also on the northeast end of A_1 and on the west side of B_1.

The differences between the four strips are most striking at the south end of the field and almost disappear at the north end, though even there the maize on the hog manure is taller and thicker at the butt than the rest.

July 22. The maize growing on the hog manure is still the tallest though that on the cow manure is nearly as large. The maize on both these strips is a foot taller than that growing on chemicals, but this in turn is well ahead of the fourth strip that received no fertilizer.

Harvest.

The crops on all the plots were sampled, cut and stacked on the 29th and 30th of September in precisely the same manner as described on page 14 of the Report of this Station for 1889. Each crop was weighed and sampled from an area of $\frac{1}{40}$ acre taken from the centre of each plot.

The crops on the separate plots were husked, weighed and harvested on the 4th and 5th of November.

Results of the Experiment.

Both kernels and stover were separately analyzed. The cob was weighed but it was assumed that its composition was alike on all the plots. The error introduced by this assumption at the most can be but very slight because the total yield of cobs is very small in comparison with that of the kernels and stover. The composition of the kernels and stover from the individual plots are given in a table appended to this paper.

From the weights of the several crops and their chemical analyses the following statement of the harvest is calculated.

The first table, Table I, presents the sum of the weights of the field-cured crops on all the plots planted in drills compared with the corresponding weights of the crops from all the plots planted in hills. The dry weights of the crops and the weights of each ingredient in the crops are given also.

TABLE I.—CROPS CALCULATED TO YIELD PER ACRE IN POUNDS.

	Planted in Drills.	Planted in Hills.
Weight field-cured	14446	13278
Water	5899	5251
Dry matter	8547	8027
Ash	339	326
Albuminoids	652	611
Fiber	1746	1612
Nitrogen-free extract	5586	5274
Fat	224	204

TABLE II.—YIELD OF THE SEPARATE PLOTS. POUNDS PER $\frac{1}{10}$ ACRE.

	No. of Plot.	Fresh Weight.	Dry Weight.	Water.	Ash.	Albuminoids. (Protein.)	Fiber.	Nitrogen-Free Extract. (Starch, Gum, etc.)	Fat.
Drills dressed with cow manure	A_1	463.9	231.5	228.2	9.8	18.8	45.0	151.3	6.6
	C_1	434.0	260.4	173.6	12.5	20.0	58.6	163.8	5.5
	E_1	356 0	208.2	147.8	7.3	16.0	39.8	139.7	5.5
	Total	1253.9	700.1	549.6	29.6	54.8	143.4	454.8	17.6
Hills dressed with cow manure	B_1	411.0	226.1	184.9	8.5	18.9	42.6	150.0	6.1
	D_1	361.9	221.9	140.0	8.5	17.6	43.1	146.6	6.1
	F_1	343.5	204.1	139.4	8.4	15.8	39.5	134.9	5.5
	Total	1116.4	652.1	464.3	25.4	52.3	125.2	431.5	17.7
Drills dressed with hog manure	A_2	470.3	271.1	199.2	11.0	22.9	52.0	178.2	7.0
	C_2	389.0	232.6	156.4	9.3	18.2	48.8	149.8	6.5
	E_2	379.1	224.9	154.2	8.6	16.8	42.8	149.9	6.8
	Total	1238.4	728.6	509.8	28.9	57.9	143.6	477.9	20.3
Hills dressed with hog manure	B_2	417.9	258.0	159 9	12.8	21.3	50.4	167.2	6.3
	D_2	351.9	207.4	144.5	8.4	16.1	39.2	138.3	5.4
	F_2	369.0	221.4	147.6	9.4	17.6	43.9	145.0	5.5
	Total	1138.8	686.8	452.0	30.6	55.0	133.5	450.5	17.2
Drills dressed with fertilizer chemicals	G_1	456.0	272.0	184.3	12.1	22.3	56.7	172.9	7.7
	I_1	307.0	196.4	110.6	7.1	15.7	42.7	126.4	4.5
	K_1	302.0	184.2	117.8	6.2	14.9	37.3	121.2	4.6
	Total	1065.0	652.6	412.7	25.4	52.9	136.7	420.5	16.8
Hills dressed with fertilizer chemicals	H_1	367.1	211.2	155.9	8.4	16.8	45.5	135.4	5.1
	J_1	288.8	187.5	101.3	7.2	14.8	40.1	121.0	4.4
	L_1	268.0	159.3	108.7	6.1	12.4	34.0	103.1	3.7
	Total	923.9	558.0	365.9	21.7	44.0	119.6	359.5	13.2
Drills, no fertilizer	G_2	295.0	185.6	109.4	6.4	12.3	35.9	125.7	5.3
	I_2	235.5	135.8	99.7	4.7	8.5	28.9	90.3	3.4
	K_2	246.1	161.4	84.7	6.8	9.3	35.4	106.2	3.7
	Total	776.6	482.8	293.8	17.9	30.1	100.2	322.2	12.4
Hills, no fertilizer	H_2	323.9	212.3	111.6	8.4	13.7	43.3	141.6	5 3
	J_2	234.5	147.4	87.1	5.8	9.1	30.5	98.2	3.8
	L_2	246.0	151.6	94.4	6.0	9.3	31.5	100.9	3.9
	Total	804.4	511.3	293.1	20.2	32.1	105.3	340.7	13.0

This table shows that a larger crop and a larger yield of every food ingredient in the crop was harvested from the planting in drills than from the corresponding planting in hills.

Table II presents in detail the yield of each ingredient from each plot, of $\frac{1}{40}$ acre. From this it appears that the three plots of drills dressed with cow manure, together yielded 7.7 per cent. more dry matter than the corresponding plots in hills.

The three plots of drills dressed with hog manure together yielded 6.1 per cent. more dry matter than the corresponding plots in hills.

Dressed with commercial fertilizers the drilled plots yielded 14.8 per cent. more dry matter than the plots in hills.

Where no fertilizer was applied the yield of dry matter from the drilled plots was only 94.4 per cent. of that from the plots planted in hills.

The facts that in three experiments on manured land the planting in drills gave larger yield while on the other hand in the fourth experiment on unmanured land the planting in hills gave a larger yield, are difficult to explain except by inequalities of soil or error in weighing the crop.

An examination of the yields of the separate plots which received no fertilizer shows that the total dry matter of the crop from two of the drilled plots, I_2 and K_2 was 297.2 while from the corresponding plots planted in hills J_2 and L_2 it was 299.0, a difference of only 1.8 pounds. It also appears from the analysis of the crop of the other two plots G_2 and H_2, that the dry weights of kernels and cobs were 102.0 and 103.5 respectively. But the dry weight of stover from plot G_2 was recorded as 83.6 pounds while from H_2 it was recorded as 108.8 pounds, a difference of 25.2. The difference in yield then between the hills and drills where no fertilizer was applied lies almost wholly in the stover of a single plot.

If these weights are correct it is surprising that an increased dry weight of 25 pounds, equivalent to 37 pounds of field-cured stover should not have carried a correspondingly increased weight of ears.

An examination of the field notes shows that the weights of the three stacks on each plot was as follows :

Plot. G_2	Plot. H_2
110	131
95	106
90	87
295	324

A single stack on H_2 weighed 21 pounds more than any other of the six, a thing which happened nowhere else in the experiment, while the ears from it did not weigh more than from the others. These facts lead us to believe that there was an error in taking the weight of a single stack on plot H_2 and that where no fertilizer was applied the actual weight of crops on the drilled plots was very nearly the same as on the plots planted in hills. The general result then of the experiment is as follows:

In this experiment the maize planted in drills gave about six per cent. larger yield of dry matter than the maize planted in hills and also a larger yield of each food ingredient.

From Table II is calculated the percentage composition of the dry matter of the several crops which is as follows ·

TABLE III.—PERCENTAGE COMPOSITION OF THE DRY MATTER OF THE CROPS.

	Cow Manure.		Hog Manure.		Mix'd Chemicals.		No Fertilizers.	
	Drills.	Hills.	Drills.	Hills.	Drills.	Hills.	Drills.	Hills.
Ash	4.2	3.9	3.9	4.4	3.8	3.9	3.7	3.9
Albuminoids	7.8	8.0	7.9	8.0	8.1	7.9	6.2	6.2
Fiber	20.5	19.2	19.7	19.4	20.9	21.4	20.8	20.6
Nitrogen-free Ex.	65.0	66.2	65.7	65.7	64.7	64.4	66.7	66.8
Fat	2.5	2.7	2.8	2.5	2.5	2.4	2.6	2.5
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

This statement of percentage composition shows two things,

1. The composition of the crop and therefore its feeding value per pound was practically the same whether planted in hills or in drills.

2. The composition of the crops grown on the different fertilizers is practically the same; but where no fertilizer was applied the per cent. of albuminoids in the crop is about 1.7 lower with a corresponding increase in the per cent. of fiber and nitrogen-free extract.

In considering these results it should be remembered that in 1888 and 1889 this land had received very considerably more of both potash and phosphoric acid than had been removed in the crops of those years, but that on the other hand the crops had removed some 60 pounds more of nitrogen from the soil per acre than had been replaced and therefore it is fair to assume that in the spring of 1890 the nitrogen of the soil was relatively at a minimum, as compared with potash and phosphoric acid. Hence where no fertilizer was applied in 1890 it was to be expected that the crop

would be reduced in quantity and would be less rich in nitrogenous substance, as a result of a striking deficiency of food supply. It is altogether likely that a considerable deficiency of either potash or of phosphoric acid would have a like effect.

It has also been shown by our experiment of the two preceding years that the per cent. of albuminoids in the crop may be strikingly increased or decreased by changing the distance of planting. To illustrate :—

The per cent. of albuminoids in the dry matter of the crops grown last year on this same land was as follows—Report for 1889, page 223 :

Distance of Planting.	Per cent. of Albuminoids in Crop.
One stalk in four feet	8.7
" " two "	7.9
" to a foot	6.4
Two stalks to a foot	5.7
Four " " "	5.6
Eight " " "	5.9

These are illustrations of a general rule that an abundant and not excessive supply of heat, water and plant food and a full supply of light are necessary for the fullest production of crop and that when the supply of either one of these factors of vegetable production is reduced beyond a certain limit the exigency is shown by a striking decrease in the proportion of nitrogenous matter which is most intimately associated with the growth and activity of assimilating cells and in consequence with the reserve supply in the seed.

The following table (Table IV), shows the largest crops of dry matter, reckoned to the acre, which were harvested in 1888 and 1889 and their percentage composition together with all crops from drills in 1890 calculated to an acre. The rows were four feet apart in all three years.

The plots marked A were on cow manure, B were on hog manure, C on commercial fertilizers, and D had no fertilizer.

As it is customary to judge of a maize crop by the yield of "shelled corn" in bushels, the yields have also been calculated in this way with the results given in the fourth column of the table. In this calculation twenty per cent. has been added to the weight of water-free kernels for the water in corn cured enough to shell and 50 pounds has been assumed as the weight of such shelled corn per bushel.

TABLE IV.—YIELD OF DRY MATTER AND "SHELLED CORN" PER ACRE FOR THREE YEARS.

Year.	Distance of Planting.	Yield of Dry Matter per Acre.	Bushels of Sound Shelled Corn.	Percentage Composition of Dry Matter. Ash.	Albuminoid.	Fiber.	Nitrogen-free Extract.	Fat.
1888	Stalks 12 inches apart,	7350	75	3.3	7.8	19.4	66.1	3.4
1888	" 6 " "	7980						
1889	" 12 " "	6144	60	3.5	6.1	21.7	69.7	3.0
1889	" 6 " "	6352						
1890A	" 10 inches apart,	9014	91	4.0	7.9	19.8	65.7	2.6
1890B	" 10 " "	9436	97	4.2	8.0	19.6	65.5	2.7
1890C	" 10 " "	8070	87	3.9	8.0	21.2	64.4	2.5
1890D	" 10 " "	6626	51	3.8	6.2	20.7	66.7	2.6

The next table, Table V, explains the last one by showing the quantities of nitrogen, phosphoric acid and potash applied each year to the soil in the fertilizer and the quantities annually removed in the crops and the consequent exhaustion or enrichment of the soil. The phosphoric acid and potash in the crops of 1890 were not determined but have been assumed to have the same relation to the nitrogen of the crops as they had in the crop of 1888.

TABLE V.—POUNDS OF NITROGEN, PHOSPHORIC ACID AND POTASH PUT ON IN FERTILIZER AND TAKEN OFF IN MAIZE CROP FOR THREE YEARS.

	Nitrogen.	Phosphoric acid.	Potash.
Put on in fertilizer in 1888 per acre	45.1	107.2	77.8
Taken off in crop in 1888 per acre	94.8	39.4	50.2
Gained (+), or lost (—) by the soil in 1888	—49.7	+67.8	+27.6
Put on in fertilizer in 1889 per acre	45.1	107.2	77.8
Taken off in crop in 1889 "	60.9	28.7	48.5
Gained or lost by the soil in 1889	—15.8	+78.5	+29.3
Gained or lost by the soil per acre in two years' cropping	—65.5	+146.3	+56.9
Put on in cow manure per acre in 1890	293	142	209
Taken off in crop per acre in 1890	114	47	60
Gained or lost by the soil per acre in 1890	+179	+95	+149
Put on in hog manure per acre in 1890	409	569	72
Taken off in crop per acre in 1890	120	50	64
Gained or lost by the soil per acre in 1890	+289	+519	+8
Put on in mixed chemicals per acre in 1890	172	162	69
Taken off in crop per acre in 1890	103	43	55
Gained or lost by the soil per acre in 1890	+69	+119	+14
Taken off in crop in 1890 from land which received no fertilizer	66	27	37
Gained or lost by the soil per acre in 1890	—66	—27	—37

The gain or loss of these three ingredients by three years cropping with maize expressed in pounds per acre is as follows:

	Nitrogen.	Phosphoric acid.	Potash.
Dressed with cow manure in 1890	+114	+241	+106
" " hog " " "	+224	+665	+ 65
" " mixed chemicals "	+ 4	+265	+ 71
No fertilizers in "	−132	+119	+ 22

In 1888 the available nitrogen supply from the fertilizer and the decaying turf were presumably sufficient for the needs of the maize crop. In 1889 the supply was probably quite insufficient while in 1890 it was probably quite in excess of the needs of the crop, at least where cow manure and hog manure were applied.

TABLE VI.—ANALYSES OF FIELD-CURED MAIZE KERNELS FROM THE PLOTS DESCRIBED IN THIS PAPER.

Plot.	ANALYSES.						ANALYSES, CALCULATED WATER-FREE.				
	Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract, (Starch, Gum, etc.)	Fat.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract, (Starch, Gum, etc.)	Fat.
A_1	38.11	.96	6.84	1.27	49.45	3.37	1.55	11.06	2.05	79.90	5.44
C_1	37.00	.85	6.43	1.15	51.46	3.11	1.35	10.15	1.82	81.77	4.91
E_1	36.93	.78	6.37	.96	51.91	3.05	1.24	10.10	1.53	82.29	4.84
A_2	36.20	.98	7.26	1.03	51.29	3.24	1.54	11.39	1.62	80.37	5.08
C_2	37.86	.85	6.51	1.01	50.75	3.02	1.37	10.46	1.63	81.67	4 87
E_2	36.08	.85	6.75	1.04	52.15	3.13	1.33	10.47	1.62	81.67	4.91
G_1	38.24	.97	6.64	1.21	49.92	3.02	1.57	10.78	1.97	80.78	4.90
I_1	38.38	.76	6 62	1.23	50.24	2.77	1.24	10.77	2.01	81.48	4 50
K_1	38.91	.81	6.39	1.12	50.11	2.66	1.36	10.46	1.82	82.00	4.36
G_2	37.59	.93	5.66	1.17	51.61	3.04	1.49	9.05	1.90	82.69	4.87
I_2	37.71	.79	5.44	1.18	51 97	2.91	1.27	8.74	1.89	83.34	4.76
K_2	35.60	.79	5.31	1·22	54.25	2.83	1.23	8 27	1.90	84.19	4.41
B_1	37.13	.83	6.52	1.25	51.05	3.22	1.36	10.37	2.05	81.11	5.11
D_1	35.24	.87	6.60	1.19	52.81	3.29	1.30	10.19	1.84	81.59	5.08
F_1	37.81	.84	6.30	1.05	51.03	2.97	1.36	10.16	1.69	82.00	4.79
B_2	36.43	.91	6.84	1.11	51.68	3.03	1.42	10.76	1.74	81.33	4.75
D_2	37.50	.81	6.47	1.08	51.28	2.86	1.32	10.43	1.74	81.91	4.60
F_2	38.43	.77	6.29	1.00	50.58	2.83	1.26	10.28	1.63	82.20	4.63
H_1	46.02	.79	5.80	1.08	43.73	2.58	1.46	10.78	2.00	80.97	4.79
J_1	37.79	.83	6.71	1.34	50.60	2.73	1.34	10.79	2.13	81.34	4.40
L_1	41.87	.78	6.05	1.23	47.72	2.35	1.29	10.40	2.12	82.14	4.05
H_2	36.44	.90	5.88	1.20	52.52	3.06	1.41	9 25	1.86	82.68	4 80
J_2	37.40	.81	5 31	1.19	52.41	2.88	1.30	8.50	1.92	83.66	4.62
L_2	38.06	.78	5.57	1.12	51.69	2.78	1.26	9.03	1.82	83.38	4 51

TABLE VII.—ANALYSES OF FIELD-CURED MAIZE STOVER FROM THE PLOTS DESCRIBED IN THIS PAPER.

Plot.	ANALYSES.						ANALYSES CALCULATED WATER-FREE.				
	Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, Gum, etc.)	Fat.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, Gum, etc.)	Fat.
A_1	59.17	2.93	2.61	13.55	21.26	.48	7.17	6.40	33.22	52.04	1.17
C_1	42.20	4.12	3.90	19.66	29.49	.63	7.12	6.75	33.84	51.04	1.25
E_1	46.02	3.59	3.64	17.87	28.11	.77	6.67	6.74	33.09	52.08	1.42
A_2	47.78	3.74	3.52	17.05	27.23	.68	7.16	6.75	32.64	52.14	1.31
C_2	41.60	3.81	3.95	19.63	30.26	.75	6.51	6.78	33.61	51.82	1.28
E_2	45.04	3.63	3.14	17.52	30.00	.67	6.63	5.70	31.86	54.59	1.22
G_1	42 52	4.23	4.08	20.10	28.31	.76	7.35	7.09	34.98	49.25	1.33
I_1	34.00	4.15	4.27	22.93	33.86	.79	6.25	6.44	34.87	51.24	1.20
K_1	39.38	3.90	4.03	20.75	31.19	.75	6.44	6.65	34.23	51.45	1.23
G_2	36 11	4.08	3.28	22.28	33.49	.76	6.36	5.12	34.88	52.44	1.20
I_2	45.43	3.02	2.98	17.86	29.87	.84	5.53	5.47	32.73	54.73	1 54
K_2	33.12	4.32	3.34	22.40	35.83	.99	6.47	5.00	33.49	53.57	1.47
B_1	51.72	3.29	3.58	15.52	25.29	.60	6.78	7.40	32.16	52.42	1.24
D_1	42.52	3.86	3.73	19.02	30.09	.78	6.72	6.49	33.09	52.34	1.36
F_1	43.68	4.38	3.66	19.07	28.47	.74	7.79	6.50	33.84	50.55	1.32
B_2	39.87	5.06	4.37	19.36	30.63	.71	8.41	7.27	32.19	50.95	1.18
D_2	44.69	4.36	3.58	17.94	28.69	.74	7.85	6.49	32.46	51.87	1.33
F_2	41.72	4.32	3.79	19.73	29.69	.75	7.41	6.50	33.87	50.94	1.28
H_1	38.62	4.31	4.20	21.27	30.88	.72	7.01	6.81	34.69	50.33	1.16
J_1	31.75	4.33	4.67	23.82	34.52	.91	6.35	6.80	34.92	50.59	1.34
L_1	39.10	3.58	3.57	21.70	31.35	.70	5.86	5.84	35.63	51.52	1.15
H_2	32.49	4.25	3.63	22.24	36.54	.85	6.29	5.37	32.94	54.11	1.29
J_2	36.76	3.76	3.20	21.34	34.06	.88	5.94	5.07	33.75	53.85	1.39
L_2	38.64	4 16	2.85	21.28	32.20	.87	6.79	4.64	34.68	52.49	1.40

ON DETERMINATION OF PHOSPHORIC ACID IN PRESENCE OF IRON AND ALUMINA.

By S. W. Johnson and T. B. Osborne.

In our paper on Determination of Phosphoric Acid in Fertilizers by the "Citrate Method," published in the Annual Report of this Station for 1889, we have stated that while by use of a certain modification of the citrate method satisfactory results were obtained in the analyses of fertilizers containing calcium phosphates, the same method applied to fertilizers containing notable quantities of iron or aluminum, gave varying percentages of phosphoric acid. We also found, in endeavoring to control our work by the rapid molybdic method now "official" in the United States, that it yielded no constant results in presence of iron and aluminum.

To quote from the paper referred, p. 261, "We had intended to give here the data for comparing the citrate method with the molybdic method in case of Thomas-Slag and Keystone Phosphate, but notwithstanding we have made many determinations and have many results by the molybdic method, we are as yet uncertain what is the true percentage of phosphoric acid in these substances and have to defer the consideration of that point to a future publication."

The method now "official" and generally employed in the United States for the determination of phosphoric acid in fertilizers, based on the use of molybdic acid in nitric acid solution, while entirely satisfactory in absence of iron and aluminum gives incorrect and in general too high results when these metals are present in considerable quantities.

In the original molybdic method as elaborated by Sonnenschein the cold solution of the substance in sulphuric or nitric acid is mixed with a large excess of molybdic solution and kept for 4 to

6 hours at a temperature near to but not exceeding 50° C. The yellow precipitate thus formed when washed with diluted molybdic solution, contains all the phosphoric acid and no bases except ammonia.

The method as modified for rapid work and now adopted by the American Association of Official Agricultural Chemists differs from the original mainly in precipitating from *hot* solutions and digesting for one hour at 65° C. When iron and aluminum are in the solution these metals are to some extent carried down with the yellow precipitate, and when this is dissolved in ammonia they are also dissolved and pass into the alkaline filtrate and thence into the magnesium phosphate.

It also easily happens that the conditions are such as to prevent all the phosphoric acid from entering the precipitate. This error is due to excess of nitric acid in the solution of the substance, or to relative deficiency of molybdic acid.

The extent to which iron and aluminum may contaminate the magnesium pyrophosphate is variable according to the acidity of the solution and the temperature at which the yellow molybdic precipitate is formed. The amount of phosphoric acid that may escape precipitation is also subject to variation, as a consequence the results commonly do not agree closely together, even in case of duplicate analyses carried on simultaneously, unless extreme care is taken to keep all the conditions strictly alike.

The amount of error thus occasioned in the hands of skilful analysts is shown by the subjoined figures.

The first results below stated were obtained with a carefully prepared solution containing very exactly 18.93 per cent. of P_2O_5 together with approximately 20 per cent. of Fe_2O_3, 4.72 per cent. of Al_2O_3 and 5.09 per cent. of MnO. These bases were present in the form of sulphates. The phosphoric acid was supplied in a solution of sodium phosphate whose content of P_2O_5 was fixed by repeated determinations with magnesium mixture. The weighed salts were dissolved together to a clear solution with help of nitric acid.

The results marked (O)* were mostly got in our private laboratory and with different reagents and on different solutions from those marked (W) and (C), which were made in the Station Laboratory by Messrs. Winton and Curtiss, respectively.

* By T. B. Osborne.

COMPARISON OF THE ORIGINAL AND THE "OFFICIAL" MOLYBDIC METHODS FOR DETERMINING PHOSPHORIC ACID IN PRESENCE OF IRON AND ALUMINUM.

	Prepared solution (P_2O_5=18.93 p. c.)	Thomas-Slag.	Keystone Concentrated Phosphate.	Grand Cayman Rock.	Bolivian Guano.	Superphosphate. No. 2447.	"Bone." No. 2452.	Prepared mixture of clean bone dust and diluted H_2SO_4.
Sonnenschein's Original Method	18.92, 18.94 (O.)	18.63 (W.) 18.65 (C.) 18.65, 18.65 (O.)	44.86, 44.86, 44.67 (O.) 44.84, 44.86 (O.) 44.84, 44.94 (W.) 45.01, 44.59 (C.)	25.47, 25.54 (O.)	16 96 (O.)	18.56, 18.37 (O.)	18.21 (O.)	22.98, 22.98 (O.)
Official Method now used in U.S.	19.26, 19.26 (O.)	19.26, 19.14 (O.)	46.68, 46.56 (O.) 47.89, 47.48 (C.) 46.19, 46.32 (W.) 45.25 (O.)	26.02 (O.) 26.12, 26.18	17.02 (O.) 17.09, 17.13 17.14, 17.24	19.14 (O.) 18.96, 19.04	18.37 (O.) 18.58, 18.52	22.91, 23.04 (O.)

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STATE OF CONNECTICUT.

ANNUAL REPORT

—OF—

The Connecticut Agricultural Experiment Station

For 1891

Printed by Order of the General Assembly.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
1892.

CORRECTION.

The valuation of Mapes' Manure for Seeding Down, No. 2222, on page 71, is greater than the cost, which should have been noted by an asterisk in the last column of the table.

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OFFICERS AND STAFF FOR 1891.

STATE BOARD OF CONTROL.

Ex-officio.

HIS EXC. MORGAN G. BULKELEY, *President.*

	Term expires
Appointed by Connecticut State Agricultural Society:	
HON. E. H. HYDE, Stafford, *Vice-President.*	July 1, 1894
Appointed by Board of Trustees of Wesleyan University:	
PROF. W. N. RICE, Middletown.	1894
Appointed by Governor and Senate:	
EDWIN HOYT, New Canaan.	1892
H. L. DUDLEY, New London.	1893

EXECUTIVE COMMITTEE.

Appointed by Board of Agriculture:

T. S. GOLD, West Cornwall. 1892

Appointed by Governing Board of Sheffield Scientific School:

W. H. BREWER, New Haven, *Secretary and Treasurer.* 1893

Ex-officio.

S. W. JOHNSON, New Haven, *Director.*

Chemists.

E. H. JENKINS, PH.D., *Vice-Director.*
A. L. WINTON, JR., PH.B.
T. B. OSBORNE, PH.D.
A. W. OGDEN, PH.B.
C. G. VOORHEES, PH.B.*

Mycologist.

ROLAND THAXTER, PH.D.†
WILLIAM C. STURGIS, PH.D.‡

Stenographer and Clerk.

MISS F. M. BIGELOW.

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helper.

HUGO LANGE.

* From Oct. 1st. † Till Aug. 1. ‡ From Aug. 1

ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established in accordance with an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, useful or injurious insects, moulds, blights, mildews, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station makes analyses of Fertilizers, Seed-tests, etc., etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.

2. That the samples are taken from stock now in the market, and in accordance with the Station instructions for sampling.

3. That the samples are fully described and retail prices given on the Station "Forms for Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs and like Associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.

All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the use of individuals will be charged for at moderate rates. The Station will undertake no work, the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of immediate general interest will be published in Bulletins, of which copies are sent to each Post Office in this State, and to every citizen of the State who applies for them. The Annual Report made to the Governor contains a *complete* account of all departments of the Station work for the preceding year.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agricul-

ture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties, sent on application.

☞ Parcels by Express, to receive attention should be *prepaid*, and all communications should be directed, *not to any individual officer*, but simply to the

AGRICULTURAL EXPERIMENT STATION,

NEW HAVEN, CONN.

☞ Station Grounds, Laboratories and Office are on Suburban street, between Whitney avenue and Prospect street, 1½ miles north of City Hall. Suburban street may be reached by the Whitney avenue Horse Cars, which leave the corner of Chapel and Church streets three times hourly, viz: on the striking of the clock and at intervals of twenty minutes thereafter.

☞ The Station has Telephone connection and may be spoken from the Central Telephone Office, 118 Court street, or from Peck & Bishop's Office in Union R. R. Depot.

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REPORT OF THE BOARD OF CONTROL.

To His Excellency, the Governor of Connecticut:

The Board of Control herewith submits its Annual Report for the year ending November first, 1891.

In obedience to the "Act Concerning Commercial Fertilizers," the Station has collected through its special deputies, Messrs. Dennis Fenn, of Milford, and F. R. Curtis, of Stratford, as far as possible, samples of all the Commercial Fertilizers selling at ten dollars or more per ton, offered or exposed for sale in Connecticut. These collections have been made in ninety-six towns and many more villages, mostly from the stock on the spring market, and numbered a total of 643 samples, representing one hundred and forty-six distinct brands. On these and on other fertilizing materials and manures have been made 281 analyses, mostly in duplicate. These analyses have been skillfully performed under the immediate charge of Messrs. Winton and Ogden, who have spared no pains to ensure their accuracy.

As in previous years the Station has undertaken to test all the samples of butter, oleomargarine, molasses, and vinegar of which analyses have been desired by the Dairy Commissioners. This work has all been performed by Dr. Jenkins, who has also appeared in court to testify to the results whenever called upon. The number of butter and oleomargarine examinations has amounted to thirty-one.

Various feeding stuffs have been analyzed or are under investigation, either at the request of consumers or with reference to the field and feeding experiments conducted by the Station.

The determination of fat in cream by the Babcock method, and the application of this method to the work of creameries, has been the subject of considerable study, with very favorable results.

The same method has been studied with reference to its use in milk-gathering creameries, and has been already adopted for practical use in one Connecticut creamery of this class.

In response to various requests the practical working of the Babcock method has been exhibited at a number of creameries and at several dairy meetings.

Very large numbers of daily tests of the individual cows in a considerable herd whose milk was sold to consumers, were made during the winter of 1890–91, to study the variations in the daily yields, the value of the different cows for dairy purposes, and the effects of change of ration on the quality and quantity of the milk.

Two field experiments have been carried on at the farm of Mr. J. H. Webb, under Dr. Jenkins' superintendence, viz :

1. On the continuous growth of Indian corn on the same land, both under application of farm manure and of commercial fertilizers.

2. To test the relative yearly yield of potatoes from tubers of different sizes when the selection of tubers is practiced for a course of years.

Mr. J. B. Olcott has devoted much time and labor to the forage gardens, especially to that established by him, with the coöperation of this Station, on his farm at South Manchester, where he now has a most flourishing and instructive exhibit of a number of species and varieties of grasses in the purest possible culture, and on a considerable scale. Mr. Olcott has visited England and France and secured thence valuable or promising additions to his nursery of economic grasses.

Dr. Osborne has devoted himself during the year to a minute study of the albuminoids or proteids of the seeds of the oat, of flax, and of cotton, and is about to reinvestigate the albuminoids of wheat.

The Station corps of chemists has been increased by the appointment of Mr. Clark G. Voorhees, Ph.B., to assist Dr. Osborne in the work on albuminoids.

The results of the careful examination of the albuminoids of Indian corn made during 1889 and 1890 by Professor R. H. Chittenden and Dr. Osborne jointly, are in course of publication in the American Chemical Journal. It is proposed to prepare an abstract of their voluminous paper for publication in the Station report. The expense of this research, so far as materials and Dr. Osborne's time during twelve months, are concerned, was borne by this Station. To the authorities of the Sheffield Scientific School, for the use of their laboratory, and to Prof. Chittenden for his personal devotion to this important investigation, the Board of Control of this Station makes due and hearty acknowledgment.

Dr. Thaxter has severed his connection with the Station to accept a professorship in Harvard University. He will report in detail his work during 1891 with reference to quince blight, potato scab, etc.

The Board of Control takes this occasion to express its appreciation of Dr. Thaxter's distinguished service to the farmers and fruit-growers of this State.

Dr. Wm. C. Sturgis assumed the duties of mycologist to the Station in August and has been giving special attention to the organisms concerned in the fermentations or sweating of tobacco.

Mr. Winton occupied several weeks of the early autumn at Suffield with observations on the curing of tobacco by artificial heat on the "Snow Modern Barn System," and is now engaged in studies upon the composition of the tobacco leaf and the chemical changes suffered in the process of growth and curing.

A detailed account of this and other work of the Station will be given in the Report of the Director, now preparing.

Five bulletins containing seventy-nine octavo pages have been issued during the year and mailed to each newspaper, postmaster, and secretary of a farmer's organization and to all citizens of the State who applied for them.

The accompanying Report of the Treasurer exhibits the financial affairs of the Station for the fiscal year which ended June 30, 1891.

In accordance with a vote of the Board at its annual meeting in January last, preliminary measures have been taken to secure a collection of samples of the varieties of Indian corn which are under cultivation in this State. The accompanying* circular has been mailed to the officers of all the agricultural societies, farmers' clubs, and granges, and to all the newspapers of the State, and to many farmers known to give particular care to their corn crop, in order to invite the sending of samples to the Station. Some responses have already been received.

This collection is primarily intended for permanent preservation in the Station museum, but will be at the service of the proper authorities for exhibition at the Columbian Exposition at Chicago in 1893.

Respectfully submitted,

WILLIAM H. BREWER, *Secretary.*

New Haven, Conn., November, 1891.

* Printed in Report of Director.

REPORT OF THE TREASURER.

WM. H. BREWER, *in account with the Connecticut Agricultural Experiment Station for the fiscal year ending June 30th, 1891.*

RECEIPTS.

From the State Comptroller	$8,000.00	
From the U. S. Treasurer	7,500.00	
Analysis fees due previous fiscal year, collected this year	170.00	
Analysis fees of this fiscal year	2,899.74	
Unclassified Receipts	38.22	
		$18,607.96

EXPENDITURES.

	State Acc't.	U. S. Acc't.	
Salaries	$5,130.00	$6,483.33	$11,613.33
General Laboratory expenses	1,419.78	5.98	1.425.76
Mycological expenses		220.91	220.91
Grass and Forage Investigation	807.10		807.10
Field Experiments		150.80	150.80
Gas	233.10		233.10
Water	147.00		147.00
Coal	484.50		484.50
The Establishment, Grounds, Repairs, etc.	749.36		749.36
Insurance	188.25		188.25
Telephone	100.50		100.50
Printing and Engraving	708.98	638.98	1,347.96
Stationery	119.28		119.28
Postage	94.29		94.29
Library	294.52		294.52
Collecting Fertilizers	388.30		388.30
Expenses of the Board	23.10		23.10
Unclassified Sundries	219.90		219.90
	$11,107.96	$7,500.00	$18,607.96

MEMORANDUM.

The year's accounts were audited July 31st, 1891, by the State Auditor of Public Accounts.

Analysis fees due last year but collected this, are placed to this year's account. The analysis fees of fertilizers known or believed to be on sale since May 1st, 1891, and subject to the law concerning the sale of commercial fertilizers, when collected will be credited to the new account.

WM. H. BREWER, *Treasurer.*

REPORT OF THE DIRECTOR.

The following pages contain a detailed account of the work of this Station during the past year so far as it is sufficiently advanced to justify its publication.

In the discussion of commercial fertilizers it is found necessary to reprint annually certain statements regarding the fertilizer law and the analysis and valuation of fertilizers, to answer the questions which are constantly addressed to the Station on these subjects.

THE CONNECTICUT FERTILIZER LAW.

The General Assembly at its session in 1882 passed a Fertilizer Law which went into effect September 1, 1882, and which repealed and took the place of all previous legislation on this subject. The law is still in force without any amendment.

Copies of the law may be had on application to the Station. Attention is specially called to the following requirements.

1. In case of fertilizers that retail at ten dollars or more per ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER shall have provided labels or statements and shall have paid the fee. Sections 1 and 3.

The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, viz: Nitrogen, Phosphoric acid and Potash. The analysis-fees in case of any fertilizer will therefore be ten, twenty or thirty dollars, according as one, two or three of these ingredients are contained or claimed to exist in the fertilizer.

2. The law also requires, in case of any fertilizer selling at ten dollars or more per ton, that a *sealed sample* shall be deposited

with the Director of the Station by the MANUFACTURER OR IMPORTER, and that a *certified statement* of composition, etc., shall be filed with him.

A statement of the per cents. of Nitrogen, Phosphoric acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the per cent. of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The per cent. of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of soluble and reverted.

The percentage of insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the chemical composition may take account of the two ingredients: Nitrogen, Phosphoric Acid.

For Potash Salts give always the per cent. of Potash (potassium oxide); that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price* shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4.

4. All "CHEMICALS" that are applied to land, such as: Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Lime (Gypsum or Land Plaster), Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 9 of the Act.

It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in Section 9, that all fertilizers be analyzed and it requires the parties making or selling them to pay for these analyses in part; the State itself paying in part by maintaining the Experiment Station.

OBSERVANCE OF THE FERTILIZER LAW.

MANUFACTURERS who have paid the Analysis Fees as required by the Law, and FERTILIZERS for which fees have been thus paid for the year ending May, 1891.

Firm.	*Brand of Fertilizer.*
Acme Fertilizer Co., Maspeth, L. I.	Connecticut Potato Fertilizer. Acme Fertilizer No. 2.
Baker, H. J. & Bro., 215 Pearl St., N. Y.	Pelican Bone Fertilizer. A. A. Ammoniated Phosphate. Special Potato Manure. Special Corn Manure. Special Tobacco Manure. Pure Raw Bone, Extra Fine. Castor Pomace.
Bowker Fertilizer Co, 43 Chatham St., Boston, Mass.	Stockbridge Tobacco Manure. " Grain Manure. " Forage Crop Manure. " Vegetable Manure. " Fruit Manure. Bowker's Hill and Drill Phosphate. " Ammoniated Bone Fertilizer. " Fish and Potash. " Pure Dry Fish. " Fresh Ground Bone. " Kainit.
Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Bradley's High Grade Tobacco Manure. " Dry Ground Fish. " Superphosphate. " Potato Manure. " Complete Manure for Potatoes and Vegetables. " for Top Dressing Grass and Grain. " for Corn and Grain. " Pure Fine Bone. " Circle Brand Bone and Potash. " Anchor Brand Fish and Potash. " Triangle A. Brand Fish and Potash. B. D. Sea Fowl Guano. Original Coe's Superphosphate. Farmers' New Method Fertilizer.
Buckingham, C., Southport, Conn.	A1 Fertilizer.
Chemical Co. of Canton, Baltimore, Md.	Special Potato Manure.
Church, Daniel T., Tiverton, R. I.	Pure Dry Ground Menhaden Guano, (A) Church's Special Fertilizer, (B) " Standard Fertilizer, (C) " Fish and Potash, (D) Acid Fish.

Firm.	*Brand of Fertilizer.*
Coe, E. Frank, 16 Burling Slip, N. Y.	Ground Bone and Potash. High Grade Phosphate. Alkaline Bone. Gold Brand Excelsior Guano. Potato Manure.
Collier White Lead & Oil Co., St. Louis, Mo.	Castor Pomace.
Cooper's, Peter, Glue Factory, 17 Burling Slip, N. Y.	Pure Bone Dust.
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Ammoniated Bone Phosphate. Potato, Hop and Tobacco Phosphate. Vegetable Bone Superphosphate. Special Potato Manure. Pure Ground Bone. Niagara Phosphate. Ammoniated Practical Superphosphate. Wheat and Corn Phosphate. New Rival Ammoniated Superphosphate. Buffalo Superphosphate, No. 2. Queen City Phosphate.
Cumberland Bone Co., Portland, Maine.	Cumberland Bone Superphosphate. Cumberland Potato Fertilizer.
Danbury Fertilizer Co., Danbury, Conn.	Ground Bone.
Darling, L. B. Fertilizer Co., Pawtucket, R. I.	Animal Fertilizer. Fine Ground Bone. Extra Bone Phosphate. Potato and Root Crop Manure.
Davidge Fertilizer Co., 121 Front St., N. Y.	Special Favorite Fertilizer.
Downes & Griffin, Birmingham, Conn.	Ground Bone.
Great Eastern Fertilizer Co., Rutland, Vt.	Great Eastern General Fertilizer for Grass and Grain. Great Eastern Vegetable, Vine and Tobacco Fertilizer. Great Eastern General Phosphate for Oats, Buckwheat and Seeding Down.
Hewitt, A. F., Groton, Conn.	Oak Lawn Ground Bone.
Hull, H. C., Meriden, Conn.	Ground Bone.
Kelsey, E. R., Branford, Conn.	Bone, Fish and Potash.
Lister's Agricultural Chemical Works, Newark, N. J.	Ammoniated Dissolved Bone. Potato Fertilizer. Standard Superphosphate of Lime. Celebrated Ground Bone.
Luce Bros., Niantic, Conn.	Ground Acidulated Fish Guano.

Firm.	*Brand of Fertilizer.*
Mapes Formula & Peruvian Guano Co., 143 Liberty St., N. Y.	Potato Manure. Complete Manure for Light Soils. Complete Manure for General Use. Tobacco Manure, Connecticut Brand. Fruit and Vine Manure. Peruvian Guano. Corn Manure. Complete Manure, "A" Brand. Fine Dissolved Bone. Tobacco Manure, Wrapper Brand. Seeding Down Manure. Grass and Grain Spring Top Dressing.
Miles Fertilizer & Oil Co., The, Milford, Conn.	IXL. Ammoniated Bone Superphosphate.
Miller, G. W., Middlefield, Conn.	Pure Ground Bone. Flour of Bone Phosphate.
National Fertilizer Co., Bridgeport, Ct.	Chittenden's Complete Fertilizer. " Ammoniated Bone Phosphate. " Fish and Potash. " Ground Bone.
Nuhn, Frederick, Waterbury, Conn.	Self Recommending Fertilizer.
Olds & Whipple, Hartford, Conn.	Castor Pomace.
Peck Bros., Northfield, Conn.	Ground Bone.
Plumb & Winton, Bridgeport, Conn.	Bone Fertilizer.
Quinnipiac Co., The, 7 Exchange Place, Boston, Mass.	Quinnipiac Phosphate. " Potato Manure. " Phosphate, (Pine Island Brand). " Market Garden Manure. " Fish and Potash, (Crossed Fishes Brand). " Fish & Potash (Plain Brand). " Dry Ground Fish. " Bone Meal. Sulphate of Potash. Muriate of Potash. Blood Bone and Meat Tankage. Nitrate of Soda.
Read Fertilizer Co., Box 3121, N. Y.	Standard Fertilizer. High Grade Farmers' Friend. Fish and Potash. Samson Brand Fertilizer.
Reese, J. S. & Co., 10 South St., Baltimore, Md.	New England Favorite. Mayflower Fertilizer. Pilgrim Fertilizer. Special Potato Fertilizer.
Rogers Mfg. Co., The, Rockfall, Conn.	Ground Bone.

Firm.	*Brand of Fertilizer.*
Rogers & Hubbard Co., Middletown, Ct.	Pure Raw Knuckle Bone Flour. Pure Ground AX Bone. Soluble Potato Manure. Fairchild's Seeding Down Formula. " Corn Formula.
Sanderson, L., New Haven, Conn.	Formula A, Mixed. Fine Ground Bone. Pulverized Bone and Meat. Blood, Bone and Meat. Nitrate of Soda. Sulphate of Ammonia. Muriate of Potash. Sulphate of Potash. Fine Ground Fish. Dissolved Bone Black.
Shoemaker, M. L. & Co., Philadelphia, Pa.	Swift Sure Superphosphate. Swift Sure Bone Meal.
Stewart, W. D. & Co., Boston, Mass.	Soluble Pacific Guano. Special Potato Manure.
Wilcox, Leander, Mystic, Conn.	Ammoniated Bone Phosphate. Potato Manure. High Grade Fish and Potash. Dry Ground Fish Guano.
Williams & Clark Fertilizer Co., 81 Fulton St., N. Y.	Americus Superphosphate. " Potato Manure. " High Grade Special. " Bone Meal. Royal Bone Phosphate.
Wilkinson & Co., 52 Williams St., N. Y.	Economical Bone Fertilzer.

ANALYSES OF FERTILIZERS.

During the past year 281 analyses of fertilizers and manurial waste products have been made at this Station. A classified list of them is given on page 26.

Of these a small number were examined for private parties and for other Experiment Stations to compare and test methods of analysis.

The Station has been fortunate in again securing the skillful services of Mr. Dennis Fenn of Milford and Mr. F. R. Curtiss of Stratford as its Agents to collect samples of fertilizers from all parts of the State.

These gentlemen during April and May visited ninety-six towns and a considerably larger number of villages, distributed as follows:

Hartford Co.	19
Tolland Co.	6
Windham Co.	11
New London Co.	10
Middlesex Co.	10
New Haven Co.	18
Fairfield Co.	16
Litchfield Co.	6
	96

Six hundred and forty-three samples were drawn representing one hundred and forty-six different brands.

In this way one or more samples were secured of nearly every brand of fertilizer which is offered for sale within the State. When several samples of a single brand were drawn in different parts of the State the analysis was performed, not on any single sample, but on a mixture made of an equal weight of each of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of any single sample.

The Station agents are instructed in every case to open at least three packages of each brand for sampling, and if the number of packages is large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core through the entire length of the bag or barrel.

As a rule, the Station will not analyze samples—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

The Station desires the coöperation of farmers, farmers' clubs, and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. All samples drawn by other than Station agents *must* be drawn in accordance with the Station's Instructions for sampling, and properly certified, if the Station analysis is desired. A copy of these instructions and blank certificates will be sent on application.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a copy of it is sent to the party who furnished the sample, and also to the manufacturer, in order that there may be opportunity for explanation or protest, if desirable, before the results are published in the Bulletin.

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

Explanations Concerning the Analysis of Fertilizers and the Valuation of their Active Ingredients.

Revised.

Nitrogen is the most rare, and commercially the most valuable fertilizing element.

Free Nitrogen is indeed universally abundant in the common air, but in this form its effects in nourishing vegetation are as yet obscure.

Organic Nitrogen is the nitrogen of animal and vegetable matters, which is chemically united to carbon, hydrogen and oxygen. Some forms of organic nitrogen, as those of blood, flesh and seeds, are highly active as fertilizers; others, as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated.

Ammonia (NH_3) *and nitric acid* (N_2O_5) are results of the decay of *organic nitrogen* in the soil and manure heap, and contain Nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda. 17 parts of ammonia or 66 parts of pure sulphate of ammonia contain 14 parts of nitrogen. 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

Phosphorus is, next to nitrogen, the most costly ingredient of Fertilizers, in which it always exists in the form of phosphates, usually those of calcium, iron and aluminum, or in case of some "superphosphates," in the form of free phosphoric acid.

Soluble Phosphoric acid implies phosphoric acid or phosphates that are freely soluble in water. It is the characteristic ingredient of Superphosphates, in which it is produced, by acting on "insoluble" or "reverted" phosphates, with diluted sulphuric acid (oil of vitriol). Once well incorporated with the soil, it gradually becomes reverted phosphoric acid.

Reverted (reduced or precipitated) Phosphoric acid means strictly, phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid. In present usage the term signifies the phosphoric acid (of various phosphates) that is freely taken up by a strong solution of ammonium citrate, which is therefore used in analysis to determine its quantity. "Reverted phosphoric acid" implies phosphates that are readily assimilated by crops.

Recent investigation tends to show that soluble and reverted phosphoric acid are on the whole about equally valuable as plant food, and of nearly equal commercial value. In some cases, indeed, the soluble gives better results on crops, in others the reverted is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric acid implies various phosphates not soluble in water or ammonium citrate. In some cases the phosphoric acid is too insoluble to be readily available as plant-food. This is especially true of the crystallized green Canada Apatite. Bone-black, bone-ash, South

Carolina Rock and Navassa Phosphate when in coarse powder are commonly of little repute as fertilizers though good results are occasionally reported from their use. When *very finely pulverized* ("floats") they more often act well, especially in connection with abundance of decaying vegetable matters. The phosphate of calcium in raw bones is nearly insoluble, because of the animal matter of the bones, which envelops it; but when the latter decays in the soil, the phosphate remains in essentially the "reverted" form. The phosphoric acid of "Thomas-Slag" and of "Grand Cayman's Phosphate" is freely taken up by crops.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid" (P_2O_5) also termed among chemists, phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

POTASSIUM is the constituent of Fertilizers, which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride).

The Valuation of a Fertilizer, as practised at this station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and similar articles, for which $30 to $50 per ton are paid, depend chiefly for their trade-value on the three substances, *nitrogen*, *phosphoric acid* and *potash*, which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above named Ingredients*, a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

The average Trade-values or retail cost in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash, as found in New England, New York and New Jersey markets, are as follows:

The Trade-Values for 1891 of Fertilizing Ingredients in Raw Materials and Chemicals.

The average Trade-Values or *retail cost per pound* of the ordinarily occurring forms of nitrogen, phosphoric acid and potash are as follows:

	Cts. per lb.
Nitrogen in ammonia salts	18½
nitrates	14½
Organic nitrogen in dry and fine ground fish, meat and blood	15½
in cotton seed meal and castor pomace	15
in fine bone and tankage	15
in fine medium bone and tankage	12
in medium bone and tankage	9½
in coarser bone and tankage	7½
in hair, horn shavings and coarse fish scrap	7
Phosphoric acid, soluble in water	8
in ammonium citrate*	7½
in dry ground fish, fine bone and tankage	7
in fine medium bone and tankage	5½
in medium bone and tankage	4½
in coarser bone and tankage	3
Potash as high-grade Sulphate and in forms free from Muriate (or Chlorides)	5½
as muriate	4½

These Trade-values were agreed upon by the Experiment Stations of Massachusetts, New Jersey, and Connecticut, for use in their respective States during 1891. They are the average prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those raw materials which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices* at the large markets of standard raw materials, such as:

Sulphate of Ammonia,	Muriate of Potash,
Nitrate of Soda,	Sulphate of Potash,
Dried blood,	Plain Superphosphate,
Azotin,	Dry Ground Fish,
Ammonite,	Bone and Tankage,

Ground South Carolina Rock.

*Dissolved from 2 grams of the unground phosphate previously extracted with pure water, by 100 c. c. neutral solution of Ammonium Citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

Valuation of Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The organic nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality.

Insoluble Phosphoric Acid is reckoned at 2 cents per pound. Potash is rated at 4½ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of Potash is reckoned at 5½ cents per pound.

In most cases the valuation of the Ingredients in Superphosphates and Specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. These charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investments, bad debts, and finally, profits.

The majority of the manufacturers agree that the average cost of mixing, bagging, handling and cartage ranges from $3.00 to $4.50 per ton.

In 1891 the average selling price of Ammoniated Superphosphates, and Guanos was $33.93 per ton, the average valuation was $28.13, and the difference $5.80, an advance of 20.6 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

In case of Special Manures the average cost was $38.84, the average valuation $31.64, and the difference $7.20, or 22.8 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of Nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

In case of *Ground Bone*, the sample is sifted into four grades and we separately compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton, by the per cent. of each grade, taking $\frac{1}{100}$th of that product, multiplying it by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

The uses of the "Valuation" are two-fold:

1. To show whether a given lot or brand of fertilizers is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price: but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

2. Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for analysis cannot decide accurately what is the *form* of nitrogen, etc., while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second-named use of valuation frequent changes of the trade-value are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth, when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of a year should be adhered to as nearly as possibly throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

The *Agricultural value* of a fertilizer is measured by the benefit received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that Peruvian guano, superphosphates, fish-scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

CLASSIFICATION OF FERTILIZERS ANALYZED.

The fertilizers and manurial waste products analyzed at the Station laboratory from November 1st, 1890, to November 1st, 1891, were as follows :

RAW MATERIALS COMMONLY USED IN MIXED FERTILIZERS.

1.	*Containing Nitrogen as the Chief Valuable Ingredient.*	
	Nitrate of Potash	1
	Nitrate of Soda	3
	Sulphate of Ammonia	4
	Cotton Seed Meal	5
	Castor Pomace	6
2.	*Containing Phosphoric Acid as the Chief Valuable Ingredient.*	
	"Odorless Phosphate"	1
	Double Superphosphate	1
	Dissolved Bone Black	3
3.	*Containing Potash as the Chief Valuable Ingredient.*	
	High Grade Sulphate	1
	Double Sulphate of Potash and Magnesia	3
	Muriate of Potash	3
	Krugit	1
4.	*Containing Nitrogen and Phosphoric Acid.*	
	Bone Manures	33
	Tankage	11
	Fish	5
	Bat Guano	1

MIXED FERTILIZERS.

Bone and Potash	5
Nitrogenous Superphosphates and Guanos	73
Special Manures	43
Home-mixed Fertilizers	19

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes	34
Unleached Wood Ashes, Canada	12
" " " Connecticut	2
Lime-kiln Ashes	1
Ashes from Brass Works	3
Rag Dust	1
Yard Manure	3
Hen Manure	1
Beef Scraps	1
Muck	1
Total	281

These analyses are discussed in the order above given. In all cases where the contrary is not stated the samples were drawn by agents of the Station from stock in dealers' hands. The regular retail prices are given wherever possible. In many cases the actual cash prices paid by puchasers have been less than those here stated.

I. Raw Materials of High-Grade Containing Nitrogen as the Chief Valuable Ingredient.

Nitrate of Soda.

Nitrate of Soda is mined in Chili and purified there before shipment. It usually contains about 16 per cent. of nitrogen, equivalent to 97 per cent. of pure nitrate of soda. It contains besides a little salt and some moisture. The usual guarantee is "96 per cent." of nitrate of soda equivalent to 15.8 per cent. of nitrogen.

3126. Sold by L. Sanderson, New Haven. Sampled by E. F. Thompson, Warehouse Point.

3140. Sold by L. Sanderson, New Haven. Sampled by Station agent.

3214. From Quinnipiac Co., New London. Sold by Olds & Whipple, Hartford. Sampled by Station agent.

Analyses.

	3126	3140.	* 3214
Water	2.32	2.40	1.46
Salt	.51	.66	.32
Sulphate of Soda	.41	.59	.12
Matters insoluble in water	.14	.19	.35
*Pure Nitrate of Soda	96.62	96.16	97.75
	100.00	100.00	100.00
*Containing Nitrogen	15.94	15.87	16.13
Cost per ton	$50.00	$50.00	$50.00
Nitrogen costs per pound in cents	**15.7**	**15.7**	**15.5**

Sulphate of Ammonia.

This article, now made on a large scale as a by-product of gas-works, usually contains over 20 per cent. of nitrogen, the equivalent of from 94 to 97 per cent. of sulphate of ammonia. The rest is chiefly moisture. The usual guarantee is 25 per cent. of ammonia, which is equivalent to 20.6 per cent. of nitrogen,

but commercial sulphate of ammonia commonly contains less than that quantity.

3131. Sold by L. Sanderson, New Haven. Sampled by E. F. Thompson, Warehouse Point.

3137. Sold by L. Sanderson, New Haven. Sampled by Station agent.

3185. From Quinnipiac Co. Sold by Olds & Whipple, Hartford. Sampled by E. F. Thompson, Warehouse Point.

3215. From Quinnipiac Co. Sold by Olds & Whipple, Hartford. Sampled by Station agent.

ANALYSES.

	3131	3137	3185	3215
Nitrogen	20.53	20.70	20.62	20.80
Equivalent ammonia	24.92	25.13	25.03	25.25
Cost per ton	$72.00	$72.00	$72.00	$72.00
Nitrogen costs per pound in cents	17.5	17.4	17.4	17.3

COTTON SEED MEAL.

The seed of the cotton plant, after ginning to remove the fiber, passes through a mill which hulls or decorticates it. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer.

Sometimes, however, hulls and seed are ground together, making "undecorticated meal" which contains considerably less nitrogen and has correspondingly less money value as a fertilizer or as a feed. When the meal has undergone heating or fermentation, its color changes from a deep yellow to brown or reddish-brown. It is then unfit for cattle food and is sold at a cheaper rate as a fertilizer.

3163 and **3209.** Sold by Olds & Whipple, Hartford. Sampled by Eugene Brown, Poquonock. These samples were of a dark brown color and not thoroughly "decorticated" or freed from hulls, which explains the lower values.

3164. "No. 1 Fort Smith." Sold by Olds & Whipple, Hartford. Sampled by Eugene Brown, Poquonock.

3167. Sold by I. L. Spencer, Suffield. Sampled by Wm. G. Viets, Thompsonville.

ANALYSES.

	3163	3209	3164	3167
Nitrogen	4.36	4.23	7.56	6.64
Phosphoric acid	1.79	1.83	3.26	2.98
Potash	1.53	1.49	2.00	1.86
Cost per ton	$24.50	$24.50	$27.00	$26.50
Nitrogen costs per pound in cents*	23.3	24.0	13.4	15.3

* Allowing 7c. and 5½c. per pound respectively for phosphoric acid and potash.

The two samples of undecorticated meal though costing $2.50 less per ton than the decorticated were very much less economical to purchase. In them nitrogen cost about ten cents more per pound than in the decorticated meal.

CASTOR POMACE.

The ground residue of castor beans from which castor oil has been extracted.

3115. Sold for L. Sanderson, New Haven, by J. C. Eddy, Simsbury. Sampled by C. P. Case.

3150. From Bowker Fertilizer Co., Boston. Sold by A. D. Bridge. Sampled by Thomas J. Stroud, Shaker Station.

3208. Sold by Eli T. Hough, agent, Poquonock. Sampled by A. E. Holcomb, Poquonock.

3218. From H. J. Baker & Co., New York. Sold by W. F. Andross, East Hartford. Sampled by Station agent.

3346. Made by Red Seal Castor Oil Co., St. Louis. Sold by Olds & Whipple, Hartford. Sampled by Station agent.

3352. Made by Collier Castor Oil Co., St. Louis. Sold by F. Ellsworth, Hartford. Sampled by Station agent.

ANALYSES.

	3115	3150	3208	3218	3346	3352
Nitrogen	5.77	4.77	5.26	4.89	5.40	5.37
Phosphoric acid	1.85	2.13	1.69	1.73	1.80	1.54
Potash	1.08	1.07	1.06	1.09	1.00	.88
Cost per ton	$20.00		$19.50	$18.50	$20.00	$20.00
Nitrogen costs per pound in cents*	13.9		15.2	15.2	15.2	15.7

* Allowing 7c. and 5½c. respectively for phosphoric acid and potash.

II. Raw Materials of High Grade containing Phosphoric Acid.

"Odorless Phosphate."

3190. A sample of this material was drawn from stock purchased of Jacob Reese of Phila., by J. H. Ives of Danbury.

Analysis.

Soluble phosphoric acid	None.
"Reverted" phosphoric acid	6.36
Insoluble phosphoric acid	17.01
Total phosphoric acid	23.37
Cost per ton	$25.00

This is Basic Slag from steel works. It will hardly come into use as a fertilizer at the price quoted above.

If Basic Slag could be purchased cheaply enough, it would be well worth the attention of those tobacco growers who endeavor to avoid the use of any but a small quantity of sulphates on their land.

Double Superphosphate.

3406. This material is made by the American Phosphate and Chemical Co. of Baltimore, Md., and the manufacturers state will be introduced into Connecticut the coming season.

The sample sent by the manufacturers as fairly representing the goods is a fine, dry grayish material having the following composition :

	Per cent.
Phosphoric acid, soluble	35.22
Phosphoric acid, reverted	5.91
Phosphoric acid, insoluble	.74
Lime	17.78
Sulphuric acid	5.44
Moisture at 100° C.	5.07
Sand and other insoluble matters	6.37
Combined water and matters undetermined	23.47
	100.00

It will be seen that this material contains nearly two and a half times as much phosphoric acid as dissolved bone black and has comparatively little sulphuric acid. If it can be bought at rea-

sonable rates this double superphosphate will be very acceptable to those tobacco growers who desire a quickly available phosphate but object to the presence of much free sulphuric acid or soluble sulphates in their fertilizers.

Dissolved Bone Black.

A superphosphate made by treating waste and spent bone black from the sugar refineries with oil of vitriol which renders nearly all of the phosphoric acid soluble in water.

3132. Sold by L. Sanderson, New Haven. Sampled by E. F. Thompson, Warehouse Point.

3133. Sold by L. Sanderson, New Haven. Sampled by Station agent.

3184. Sold by Olds & Whipple, Hartford. Sampled by E. F. Thompson, Warehouse Point.

Analyses.

	3132	3133	3184
Soluble phosphoric acid	15.58	16.24	16.40
Reverted phosphoric acid	.06	.10	.23
Insoluble phosphoric acid	.06	.09	none.
Cost per ton	$26.00	$26.00	$26.00
Soluble phosphoric acid costs per pound in cents	8.3	7.95	7.92

III. Raw Materials of High Grade Containing Potash.

Double Sulphate of Potash and Magnesia.

This material is usually sold as "sulphate of potash" or "manure salts," on a guarantee of "48–50 per cent. sulphate," which is equivalent to 25.9–27 per cent. of actual potash. Besides some 46–50 per cent. of sulphate of potash it contains over 30 per cent. of sulphate of magnesia, chlorine equivalent to 3 per cent. of common salt, a little sulphate of soda and lime, with varying quantities of moisture.

3128. Sold by L. Sanderson, New Haven. Sampled by E. F. Thompson, Warehouse Point.

3141. Sold by L. Sanderson, New Haven. Sampled by Station agent.

3187. Sold by Olds & Whipple, Hartford. Sampled by E. F. Thompson, Warehouse Point.

ANALYSES.

	3128	3141	3187
Potash	26.61	25.22	25.46
Equivalent sulphate of potash	49.2	46.7	47.1
Cost per ton	$30.00	$30.00	$30.00
Potash costs per pound in cents	5.6	5.9	5.9

MURIATE OF POTASH.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride), 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water. It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of actual potash.

3127. Sold by L. Sanderson, New Haven. Sampled by E. F. Thompson, Warehouse Point.

3134. Sold by L. Sanderson, New Haven. Sampled by Station agent.

3217. From Quinnipiac Co., New London. Sold by Olds & Whipple, Hartford. Sampled by Station agent.

ANALYSES.

	3127	3134	3217
Potash	49.60	50.62	52.68
Cost per ton		$42.50	$43.00
Potash costs per pound in cents		4.2	4.1

IV. RAW MATERIALS CONTAINING NITROGEN AND PHOSPHORIC ACID.

BONE MANURES.

The terms "Bone Dust," "Ground Bone," "Bone Meal" and "Bone" applied to fertilizers, sometimes signify material made from dry, clean and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon, and grease—and if taken from garbage heaps, with ashes or soil adhering; again they denote mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam-tanks in order to recover grease, and are then dried and

sometimes sold as "tankage;" or, finally, they apply to bone from which a large share of the nitrogen has been extracted in the glue manufacture. The nitrogen of all these varieties of bone when they are in the same state of mechanical subdivision has essentially the same fertilizing value.

1. *Sampled by Station Agents.*

On pages 34 to 36 are tabulated 20 analyses.

The last of these, No. **3199,** Lister's Ground Bone, is a mixture of bone with salt-cake.

The average cost of the other 19 samples is $33.66 and the average valuation $35.58, showing a more satisfactory agreement between cost and valuation than in former years.

Samples **3176** Ground Raw Knuckle Bone, and **3177** Pure Ground A X Bone, both made by the Rogers and Hubbard Co., Middletown, and sampled by Station agent from stocks of the City Coal and Wood Co. of New Britain, and A. E. Kilburn of East Hartford, were analyzed with the results given below.

They are not included in the tables for the reason that the manufacturers objected that the mechanical condition was very different from that which their goods had generally shown, and as the same sieves were used in screening as formerly, they felt sure that some error had been made.

Further samples of the same brands were accordingly drawn and analyzed.

ANALYSES.

Mechanical Analyses.

	3176	3177
Fine, smaller than $\frac{1}{10}$ inch	58	30
Fine medium, smaller than $\frac{1}{16}$ inch	42	30
Medium, smaller than $\frac{1}{8}$ inch	--	25
Coarse, larger than $\frac{1}{8}$ inch	--	15
	100	100

Chemical Analyses.

Nitrogen	4.06	4.55
Phosphoric acid	25.20	20.89
Valuation per ton	$43.26	$32.84

Bone Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3196	Pure Bone Dust.	Peter Cooper's Glue Factory, N. Y.	Wilson & Burr, Middletown.	$28.00
3198	Fine Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	City Coal & Wood Co., New Britain.	34.00
			W. W. Cooper, Suffield.	38.00
3138	Fine Ground Bone.		L. Sanderson, New Haven.	32.00
3220	Pure Fine Ground Bone.	Bradley Fertilizer Co., 27 Kilby St., Boston.	Strong & Tanner, Winsted.	34.00
			Waterbury & June, Greenwich.	34.00
			R. A. Parker, Warehouse Point.	36.00
			J. A. Lewis, Willimantic.	32.00
			J. E. Holmes, Stratford.	32.00
			W. H. Cheney's Sons, So. Manchester.	38.00
			City Coal & Wood Co., New Britain.	33.00
			Carter & Strong, Manchester.	36.00
3248	Raw Knuckle Bone Flour.	Rogers & Hubbard Co., Middletown.	Manufacturer.	40.00
3182	Ground Bone.	Plumb & Winton, Bridgeport.	Manufacturer.	30.00
3179	Swift Sure Bone Meal.	M. L. Shoemaker & Co., Philadelphia.	J. P. Barstow & Co., Norwich.	38.00
			F. Ellsworth, Hartford.	40.00
3200	Chittenden's Ground Bone.	National Fertilizer Co., Bridgeport.	E. W. Wilson, Ellington.	----
			L. W. Currier, Bridgeport.	35.00
33 19	Fine Ground Bone.	Quinnipiac Co., New London.	G. M. Williams, New London.	35.00
			John Greenwood, Norwalk.	34.00
			Olds & Whipple, Hartford.	35.00

Bone Manures Sampled by the Station.— *Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3180	Pure Ground Bone.	E. Frank Coe, 16 Burling Slip, N. Y.	I. W. Denison, Mystic.	$35.00
			Wheeler & Howe, Bridgeport.	30.00
			J. P. Barstow & Co., Norwich.	32.00
3181	Pure Ground Bone.	Peck Bros., Northfield.	Strong & Tanner, Winsted.	32.00
			Manufacturer.	28.00
3192	Bone Meal.	Danbury Fertilizer Co., Danbury.	Manufacturer.	32 50
3349	Pure Ground A. X. Bone.	Rogers & Hubbard, Middletown.	Manufacturer.	32.00
3222	Pure Bone Meal.	Williams & Clark Co., 83 Fulton St., N. Y.	D. B. Wilson, Waterbury.	35.00
			Chas. Kingsbury, So. Coventry.	36.00
3194	Ground Bone.	Mapes Formula & Peruvian Guano Co., N. Y.	A. N. Clark, Milford.	34.00
3178	Pure Ground Bone.	Downs & Griffin, Ansonia.	Abbott & Co., Birmingham.	38.00
3195	Fine Ground Bone.	Bowker Fertilizer Co., Boston, Mass.	T. Hallock & Co., Birmingham.	33.00
3347	G. W. Miller's Pure Ground Bone.	G. W. Miller, Middlefield.	Manufacturer.	30.00
3197	Pure Ground Bone.	Crocker Fertilizer Co., Buffalo, N. Y.	F. N. Barton, Watertown.	36.00
			H. C. Aborn, Ellington.	36.00
3199	Lister's Ground Bone.	Lister's Agricultural Chemical Works, Newark, N. J.	J. P. Barstow & Co., Norwich.	30.00

Analyses of Bone Manures.—Sampled by the Station.

Station No.	Name or Brand.	Chemical Analysis.		Mechanical Analysis.				Cost per ton.	Valuation per ton.	Percentage difference between cost and valuation.
				Finer than			Coarser than			
		Nitrogen.	Phos. Acid.	$\frac{1}{16}$ inch.	$\frac{1}{8}$ inch.	$\frac{1}{4}$ inch.	$\frac{1}{4}$ inch.			Valuation exceeds cost.
3196	Peter Cooper's Pure Bone Dust	1.64	30.92	42	18	19	21	$28.00	$37.41	25.2
3198	Darling's Fine Bone	2.44	27.31	64	25	10	1	36.00	41.28	12.8
3138	Sanderson's Fine Ground Bone	3.68	24.41	37	22	41	0	32.00	36.47	12.3
3220	Bradley's Pure Ground Bone	3.25	22.50	68	27	5	--	34.00	38.21	11.0
3248	Rogers & Hubbard Co's. Raw Knuckle Bone Flour	3.92	25.39	65	35	--	--	40.00	43.84	8.7
3182	Plumb & Winton's Ground Bone	3 99	21.20	40	21	21	18	30.00	32.58	7.9
3179	Shoemaker's Swift Sure Bone Meal	6.02	21.04	60	32	8	--	40.00	42.97	6.9
3200	National Fertilizer Co's. Ground Bone	3.54	23.18	44	26	18	12	33.00	35.06	5.9
3198	Quinnipiac Co's. Fine Ground Bone	2.88	22.84	66	22	9	3	35.00	37.02	5.4
3180	E. F. Coe's Ground Bone	2.66	22.13†	52	23	13	12	32.00	33.54	4.6
3181	Peck Bro's. Pure Ground Bone	4.32	20.85	13	30	37	20	28.00	29.33	4.5
3192	Danbury Fertilizer Co's. Bone Meal	3.99	22.40	32	28	30	10	32.50	33.70	3.5
3249	Rogers & Hubbard Co's. Pure Ground AX Bone	4.06	22.26	32	23	32	13	32.00	33.17	3.5
3222	Williams, Clark & Co's. Pure Bone Meal	2.52	21.97	72	22	6	--	35.00	35.71	1.9
3194	Mapes' Ground Bone	3.85	25.91	11	36	47	6	34.00	34.56	1,6
										Cost exceeds valuation.
3178	Downs & Griffin's Pure Ground Bone	4.34	21.66	53	22	17	8	38.00	36.81	3.2
3195	Bowker's Fine Ground Bone	4.07	25.46	2	14	84	--	33.00	31.98	3.2
3247	G. W. Miller's Pure Ground Bone	3.79	22.61	21	20	22	37	30.00	29.02	3.4
3197	Crocker's Pure Ground Bone	4.44	23.35	24	34	25	17	36.00	34.30	4.9
3199	Lister's Ground Bone	3.53	13.98	23	22	20	25	30.00	19.54	53.5

† Also contains .94 per cent. of potash.

2. *Manufacturers' Samples.* 3. *Samples drawn by private individuals.*

Here are given analyses of samples sent to the Station by the manufacturers. No samples of these brands were drawn by the sampling agents, and it is therefore necessary,—to meet the requirement of the law which calls for an annual analysis of each brand—to analyze the samples deposited at the Station by manufacturers. With these are the analyses of two samples drawn by private individuals.

3272. A1 Bone, ground by the National Fertilizer Co., Bridgeport, for C. Buckingham, Southport, who is the dealer. Sampled and sent by C. Buckingham.

3280. Oak Lawn Pure Ground Bone made and sampled by A. F. Hewitt, Groton.

3355. Ground Bone, made and sampled by H. C. Hull, Meriden.

3296. Ground Bone, made and sampled by the Rogers Manufacturing Co., Rockfall, Conn.

3116. Fertilizer made by Plumb and Winton. Sampled and sent by Wm. R. Hopson, Bridgeport.

3122. H. J. Baker's Pure Raw Bone, extra fine. Sampled and sent by W. F. Andross, East Hartford.

MECHANICAL ANALYSES.

	3272	3280	3355	3296	3116	3122
Fine, smaller than $\frac{1}{30}$ inch	55	61	5	36	50	47
Fine medium, smaller than $\frac{1}{15}$ inch	38	22	6	32	20	53
Medium, smaller than $\frac{1}{7}$ inch	5	12	9	30	22	0
Coarse, coarser than $\frac{1}{7}$ inch	2	5	80	2	8	0
	100	100	100	100	100	100

CHEMICAL ANALYSES.

	3272	3280	3355	3296	3116	3122
Nitrogen	3.98	2.77	4.16	2.66	5.54	3.72
Phosphoric acid	16.25	27.04	21.40	26.93	13.41	24.65
Valuation per ton	$30.95	40.74	21.87	37.16	31.74	41.34

Tankage.

This name is properly applied only to the sediment remaining in tanks where meat scrap with some bone is rendered to separate the fat. After boiling or superheating with steam, the fat rises to the surface of the water and is removed, the soup is run off, and the settlings at the bottom are dried and sold as tankage. Such material contains as large or larger percentage of nitrogen than of phosphoric acid. But the name tankage is also loosely applied to mixtures that consist largely of bone and do not differ greatly in composition from pure bone.

1. *Sampled by Station Agent.*

3216. Blood Bone and Meat from the Quinnipiac Co. Sampled from stock of the dealer, Olds & Whipple, Hartford.

3135. Blood Bone and Meat. Sampled from stock of L. Sanderson, New Haven.

3139. Pulverized Bone and Meat. Sampled from stock of L. Sanderson.

2. *Manufacturer's Sample and Samples drawn by private individuals.*

3275. Blood and Meat Tankage made by F. S. Andrew & Co., New Haven. Sampled by F. S. Andrew.

3149. Tankage sold by Bowker Fertilizer Co., Boston. Sampled by T. J. Stroud from stock of A. D. Bridge, Hazardville.

3186. Dried Blood and Animal Matter from Quinnipiac Co. Sampled by E. F. Thompson, Warehouse Point, from stock bought of Olds & Whipple, Hartford.

3130. Pulverized Bone and Meat, and **3129** Blood Bone and Meat. Both from L. Sanderson, New Haven. Sampled and sent by E. F. Thompson, Warehouse Point.

3169. Tankage made by Daniel S. Wadsworth, Hartford. Sampled and sent by Aug. Pouleur, Windsor.

3372. Tankage made by Daniel S. Wadsworth, Hartford. Sampled by R. E. Pinney, Suffield.

Analyses of Tankage.

Station No.	Name or Brand.	Chemical Analysis.		Mechanical Analysis. Finer than				Coarser than	Cost per ton.	Valuation per ton.
		Nitrogen.	Phos. acid.	$\frac{1}{35}$ inch.	$\frac{1}{25}$ inch.	$\frac{1}{12}$ inch.	$\frac{1}{6}$ inch.	$\frac{1}{6}$ inch.		
3216	Quinnipiac Co's. Blood, Bone and Meat	4.93	13.61	64	22	13	1	--	$32.00	$32.18
3135	Sanderson's Blood, Bone and Meat	5.80	15.43	61	19	17	3	--	35.00	34.46
3139	Sanderson's Pulverized Bone and Meat	5.14	20.58	84	12	3	11	--	36.00	42.41
3275	F. S. Andrews & Co's. Blood and Meat Tankage	4.02	18.14	15	26	27	32	--	----	25 22
3149	Bowker's Tankage	6.41	15.33	45	25	21	9	--	----	33.51
3186	Olds & Whipple's Dried Blood and Animal Matter	5.65	18.04	71	17	12	--	--	----	38.90
3130	Sanderson's Pulverized Bone and Meat	5.71	19.16	87	10	3	--	--	35.00	42.58
3129	Sanderson's Blood, Bone and Meat	7.93	10.81	61	19	16	4	--	35.00	34.30
3169	D. S. Wadworth's Tankage	3.56	24.26	46	18	20	16	--	25.00	35.79
3272	Wadworth's Tankage	2.79	26.11	28	10	8	54	--	20.00	29.15

Dried and Acidulated Dried Fish.

3351. Bowker's Dry Fish. Sampled by manufacturer, contained 7.93 per cent. of nitrogen, equivalent to 9.63 per cent. of ammonia.

3219. Bowker's Dry Fish. Sampled by Station agent from stock of F. S. Bidwell, Windsor Locks, and Bucklin & Hardin, North Glastonbury. To this analysis the manufacturers object that it does not represent the character of the goods; as all dry fish that has left their factory this year they are very positive is fully up to guarantee. On account of this protest sample **3351** was analyzed and shows one-half of one per cent. more nitrogen. Sample **3219** contains 7.45 per cent. nitrogen, equivalent to 9.05 per cent. ammonia.

3345. Pure Ground Acidulated Fish, made by Luce Bros., Niantic. Sample sent by manufacturers contains 7.19 per cent. nitrogen, equivalent to 8.72 per cent. of ammonia.

MIXED FERTILIZERS.

I. Bone and Potash.

3350. Bone, Meat and Potash, made by F. Nuhn, Waterbury. Sampled by Station agent.

3329. Flour of Bone Phosphate, made by G. W. Miller, Middlefield. Sampled by Station agent.

3343. Fairchild's Bone and Potash for Seeding Down, made by The Rogers & Hubbard Co., Middletown. Sampled by Station agent.

3339. Ground Bone and Potash, made by E. Frank Coe, New York. Manufacturer's sample.

3341. Bone and Potash, Circle Brand, made by Bradley Fertilizer Co., Boston, Mass. Manufacturer's sample.

The sample **3329** is a mixture of bone flour with nitrate of soda and potash salts.

Analyses of Bone and Potash.

Mechanical Analyses.

	3350	3329	3343	3339	3341
Fine, smaller than $\frac{1}{50}$ inch	47	64	63	50	45
Fine medium, smaller than $\frac{1}{25}$ inch	25	29	28	22	38
Medium, smaller than $\frac{1}{12}$ inch	14	7	8	15	16
Coarse, larger than $\frac{1}{12}$ inch	14	0	1	13	1
	100	100	100	100	100

CHEMICAL ANALYSES.

	3350	3329	3343	3339	3341
Nitrogen as nitrate	----	1.48	----	----	----
Nitrogen as ammonia	.15	.19	----	----	----
Nitrogen, organic	3.93	2.94	2.84	2.22	2.91
Nitrogen, total	4.08	4.61	2.84	2.22	2.91
Phosphoric acid	20.39	13.82	18.75	21.42	16.71
Potash	1.07	5.66	13.42	1.11	2.24
Chlorine	1.24	5.27	13.04	2.64	3.00
Cost per ton	$32.50	35.00	42.50	----	----
Valuation per ton	$34.62	35.96	43.61	31.33	29.94

II. NITROGENOUS SUPERPHOSPHATES AND GUANOS.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid and in most cases potash, which are not designed by their manufacturers for use on any special crop. "Special Manures" are noticed further on. Fish scrap is here included as it is sometimes acidulated with oil of vitriol to preserve it, thus making it a nitrogenous superphosphate.

1. *Samples drawn by Station Agents.*

In the tables on pages 44 to 57 are tabulated the analyses of fifty-seven brands made on samples collected by the Station agents.

THE GUARANTEES.

The law of Connecticut requires every package of fertilizer to bear a statement of the actual composition of the goods. This usually expresses the quantities of nitrogen, phosphoric acid and potash within certain limits, as "nitrogen 2–4 per cent."

If a fertilizer with such a guarantee actually contains 2 per cent. of nitrogen, it is within the manufacturer's guarantee.

It is the lowest figures of the guarantee therefore that purchasers should regard.

Of the fifty-seven brands here reported fourteen are below their minimum guarantee in respect of one ingredient, and six in respect of two ingredients. That is, one-third of all the nitrogenous superphosphates in our market contain less of one or of several ingredients than they are claimed to contain.

It may be urged that an excess of one ingredient over the guarantee should be held to make good the deficiency of another. But with reasonable care and skill in the manufacture and in the sampling and analysis of the goods the actual analysis should not fall below the minimum guaranteed in any respect particularly when such wide limits are allowed in the guarantees themselves.

The Actual Chemical Composition.

The different brands differ greatly in composition.

Below are given the highest and lowest percentages of each ingredient and also the average composition of the nitrogenous superphosphates.

The samples of dry ground fish, Peruvian guano and bone treated with oil of vitriol are not included in this table.

Composition of Nitrogenous Superphosphates. Season of 1891.

	Highest.	Lowest.	Average.
Nitrogen as nitrates	1.08	0	.14
" " ammonia	2.55	0	.28
" organic	6.06	.73	2.47
Total Nitrogen	6.06	.73	2.89
Soluble Phosphoric Acid	10.51	1.31	5.71
Reverted " "	8.04	1.19	3.19
Insoluble " "	2.85	.15	1.34
Available Phosphoric Acid	12.97	4.23	8.90
Total " "	14.78	5.19	10.24
Potash	9.95	.93	3.48
Chlorine	7.88	none	3.35
Cost per ton*	$44.00	$25.00	$33.93
Valuation per ton*	$34.18	$19.90	$38.13

* Excluding the last two analyses in the table, in which the cost exceeds valuation by considerably more than 50 per cent.

This table shows that the nitrogen in the nitrogenous superphosphates now in market varies from three-quarters of one per cent. to six per cent., phosphoric acid from five to fourteen and three-quarters per cent., and potash from less than one per cent. to ten.

It is evident that among the various brands there is a great difference in the quantity of actually valuable ingredients per ton and these differences must be studied by any one who would purchase economically.

A comparison of these tables with those of former years will also show that certain brands have about the same composition

year after year, while others fluctuate considerably and cannot be depended on to be the same from year to year.

Cost and Valuation.

Cost.

The method used to ascertain the retail cash price of the phosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis when done is reported to each dealer from whom a sample was taken with an enclosed postal card addressed to the Station, and a request to note on it whether the retail cash price is correctly given and to mail to the Station.

To each manufacturer is also sent a request that he will notify the Station regarding the probable average cash price at freight centers in Connecticut, of such brands as he sells in the State.

From these data the average prices are computed.

Valuation.

The valuation has been computed in all cases as already described in detail on page 24.

Percentage Difference given in the last column of the table shows the percentage excess of the cost price over the average retail cost of the nitrogen, phosphoric acid and potash contained in the fertilizer.

This information puts the purchaser into a position where he can figure as to the probable relative value of the different brands and the probable relative economy of buying fertilizers mixed or unmixed.

Which method of buying is preferable can only be determined by each individual farmer who should know best what his soil and crops need and what his facilities for purchase and payment are.

No general rule can be given. In one case ready-mixed, in another, home-mixed fertilizers may be found the more profitable to use.

The average cost of the nitrogenous superphosphates as already given is $33.93. The average valuation, $28.13 and the percentage difference 20.6.

Last year the corresponding figures were:

Average cost $33.80, Average valuation $28.57, Percentage difference 18.3.

Nitrogenous Superphosphates and Guanos Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3183	Acidulated Fish Guano.	Leander Wilcox, Mystic, Conn.	H. K. Brainard, Thompsonville.	$20.00
3136	Dry Ground Fish.	L. Sanderson, New Haven, Conn.	Manufacturer.	30.00
3344	Pure Fine Dissolved Bone.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes' Branch, Hartford.	32.00
3172	Dry Ground Fish Guano.	Leander Wilcox, Mystic, Conn.	H. K. Brainard, Thompsonville.	33.00
			W. W. Cooper, Suffield.	35.00
			Manufacturer.	30.00
			J. W. Reynolds, Goodspeeds.	30.00
3253	Pure Dry Ground Menhaden Guano, A.	Joseph Church & Co., Tiverton, R. I.	Manufacturer.	34.00
3234	Cumberland Bone Superphosphate.	Cumberland Bone Co., Portland, Me.	L. D. Post, Andover.	30.00
3257	Dry Ground Fish.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	D. W. Spencer, Centerbrook.	32.00
			J. E. Holmes, Stratford.	38.00
			W. F. Andross, E. Hartford.	35.00
			R. A. Parker, Warehouse Point.	34.00
3232	Bone, Fish and Potash.	E. R. Kelsey, Branford, Conn.	Wilson & Burr, Middletown.	28.00
			J. R. Barnes, Cheshire.	25.00
			Manufacturer.	20.00
3320	Sanderson's Formula A.	L. Sanderson, New Haven, Conn.	Manufacturer.	35.00
			E. A. Atwater, Cheshire.	36.00
3213	Dry Ground Fish.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	J. F. Silliman, New Canaan.	36.00
			P. & G. Williams, New London.	40.00
3331	Chittenden's Fish and Potash.	National Fertilizer Co., Bridgeport, Conn.	G. A. & H. B. Williams, E. Hartford.	32.00
			Prindle & Clark, W. Cheshire.	33.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3255	Standard C Brand Fertilizer.	Joseph Church & Co., Tiverton, R. I.	Manufacturer.	$35.00
3254	Special B Brand Fertilizer.	Joseph Church & Co., Tiverton, R. I.	Manufacturer.	37.00
3336	Swift Sure Superphosphate.	M. L. Shoemaker & Co., Philadelphia, Pa.	Wm. H. Filley, Windsor.	40.00
			J. P. Barstow & Co., Norwich.	37.00
			F. Ellsworth, Hartford.	38.00
3321	Genuine Peruvian Guano.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes' Conn. Valley Branch, Hartford.	41.00
3291	Complete Manure, A Brand.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	D. B. Wilson, Waterbury.	36.00
			Birdsey & Foster, Meriden.	36.00
			F. S. Bidwell, Windsor Locks.	36.00
			Quinnebaug Store, Danielsonville.	37.00
			Mapes' Conn. Valley Branch, Hartford.	35.00
			D. Beers, Danbury.	36.00
			Wilson & Burr, Middletown.	36.00
			A. N. Clark, Milford.	37.00
			Southington Lumber & Feed Co., Southington.	35.15
			J. P. Barstow & Co., Norwich.	36.00
			Strong & Backus, Colchester.	34.00
3288	Complete Manure for General Use.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Southington Lumber & Feed Co., Southington.	35.00
			Mapes' Conn. Valley Branch, Hartford.	38.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3224	Chittenden's Ammoniated Bone Phosphate.	National Fertilizer Co., Bridgeport, Conn.	W. L. Currier, Bridgeport.	$35.00
			E. P. Matherson, Promfret.	----
			E. B. Clark, Milford.	30.00
			G. A. & H. B. Williams, E. Hartford.	32.00
			F. L. Leighton & Co., Wallingford.	35.00
			Prindle & Clark, W. Cheshire.	31.00
			C. D. James, Danielsonville.	----
			J. S. Worthington, Gildersleeve.	----
			D. G. Penfield, Danbury.	35.00
			G. W. Eaton, Plainville.	33.00
3248	Bradley's Farmers New Method Fertilizer.	Bradley Fertilizer Co., 127 Kilby St., Boston, Mass.	J. E. Leonard, Jewett City.	32.00
			City Coal & Wood Co., New Britain.	33.00
			W. F. Andross, E. Hartford.	33.00
			D. N. Clark & Sons, Milford.	29.00
			G. W. Carver, Putnam.	29.00
			G. R. Fowler, Central Village.	34.00
			Carter & Strong, Manchester.	34.00
			D. W. Spencer, Centerbrook.	34.00
			J. M. Young, Norwich.	30.00
			R. D. Williams, Collinsville.	32.00
3235	A. A. Ammoniated Superphosphate.	H. J. Baker & Bro., 215 Pearl St., New York.	E. H. Talcott, Torrington.	37.50
			J. H. Ives, Danbury.	37.50
			A. L. Winton, Bridgeport.	37.50
			H. L. Foote, Brookfield Junction.	37 50
			G. W. Walker, Saybrook.	37.50
			E. F. Hawley, Newtown.	37.50
			W. F. Andross, E. Hartford.	37.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3262	Lister's Standard Phosphate.	Lister's Agricultural Chemical Works, Newark, N. J.	W. H. Parmelee, Essex.	$35.00
3174	High Grade Fish and Potash.	Leander Wilcox, Mystic, Conn.	H. K. Brainard, Thompsonville.	32.00
			F. E. Fowler, Montville.	30.00
			Manufacturer.	31.00
			Manufacturer.	31.00
3334	Pilgrim Fertilizer.	J. S. Reese & Co., 10 Broad St., Baltimore, Md.	H. F. Standish, Andover.	27.00
			A. H. Anderson, Putnam.	32.00
3175	Ammoniated Bone Phosphate.	Leander Wilcox, Mystic, Conn.	Manufacturer.	33.00
			J. W. Reynolds, Goodspeeds.	33.00
3312	Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	City Coal & Wood Co., New Britain.	36.00
			W. W. Cooper, Suffield.	38.00
3333	New England Favorite.	J. S. Reese & Co., 10 Broad St., Baltimore, Md.	Montgomery & Co., Groton.	30.00
			H. F. Standish, Andover.	32.00
			A. H. Anderson, Putnam.	35.00
3306	Quinnipiac Phosphate.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	D. N. Medbury, Pomfret.	35.00
			G. B. Whitehead, Green's Farms.	36.00
			J. F. Silliman, New Canaan.	38.00
			Chandler & Morse, Putnam.	35.00
			G. M. Williams, New London.	35.00
			C. A. Young, Danielsonville.	37.00
			J. P. Little, Columbia.	36 00
			Olds & Whipple, Hartford.	38.00
			J. S. Worthington, Gildersleeve.	35.00
			A. J. Martin, Wallingford.	35.00
			D. C. Wood, Stratford.	37.00
			John Greenwood, Norwalk.	38.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3241	Bradley's Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Dix & Wells, Wethersfield.	$35.00
			T. F. Powers, Waterford.	34.00
			Strong & Tanner, Winsted.	35.00
			D. Beers, Danbury.	36.00
			Peck Bros., Northfield.	35.00
			S. A. Billings, Meriden.	38.00
			City Coal & Wood Co., New Britain.	35.00
			Quinnebaug Store, Danielsonville.	36.00
			J. E. Leonard, Jewett City.	36.00
			D. N. Clark, Shelton.	35.00
			Wheeler & Howe, Bridgeport.	37.00
			F. S. Bidwell, Windsor Locks.	34.00
			Burtiss & Mead, New Canaan.	38.00
			Warner, Taylor & Curtiss, Sandy Hook.	36.00
			D. W. Spencer, Centerbrook.	38.00
			J. E. Comstock, New London.	36.00
			A. L. Sternberg, Hartford.	35.00
			Carter & Strong, Manchester.	----
			Waterbury & June, Greenwich.	38.00
			H. C. Aborn & Co., Ellington.	35.00
			G. R. Fowler, Central Village.	34.00
			John Wells, Hebron.	39.00
			R. A. Parker, Warehouse Point.	35.00
3227	Fish and Potash, D Brand.	Joseph Church & Co., Tiverton, R. I.	W. W. Cooper, Suffield.	28.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3325	Americus Brand Ammoniated Bone Superphosphate.	Williams & Clark Fertilizer Co., 83 Fulton St., New York.	D. B. Wilson, Waterbury.	$35.00
			Strong & Backus, Colchester.	33.00
			Geo. Beaumont, Wallingford.	35.00
			C. E. Stagg, Stratford.	34.00
			Daniel Morgan, Mystic.	35.00
			Joseph Roode, Griswold.	36.00
			H. K. Brainard, Thompsonville.	35.00
			John Wells, Hebron.	----
			J. H. Ray & Son, Greenwich.	32.00
			J. P. Little, Columbia.	36.00
			John Bransfield, Portland.	38.00
			Hale, Day & Co., South Manchester.	36.00
			H. L. Vibberts, Manchester.	40.00
			T. C. Greene, Torrington.	37.00
			J. P. Kingsley & Sons, Plainfield.	33.00
3309	Market Garden Phosphate.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	G. B. Whitehead, Green's Farms.	40.00
			E. B. Clark, Milford.	39.00
			J. H. Jennings, Green's Farms.	----
3323	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport, Conn.	E. H. Wilson, Ellington.	----
			C. D. James, Danielsonville.	40.00
			G. H. & H. B. Williams, E. Hartford.	41.00
			D. G. Penfield, Danbury.	45.00
			J. S. Worthington, Gildersleeve.	40.00
			F. L. Leighton & Co., Wallingford.	42.50
			Prindle & Clark, W. Cheshire.	----
			S. D. Woodruff, Orange.	38.00
			David Fitzgerald, Stratford	42.00
			W. W. Cooper, Suffield.	38.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3235	May Flower Fertilizer.	J. S. Reese & Co., 10 Broad St., Baltimore, Md.	Waldo Tillinghast, Plainfield.	$30.00
			H. F. Standish, Andover.	29.00
			H. H. Davenport, Pomfret.	----
			A. H. Anderson, Putnam.	34.00
3228	High Grade Phosphate.	E. Frank Coe, 16 Burling Slip, New York.	C. H. Lounsbury, Seymour.	36.00
			J. Amidon, Wethersfield.	35.00
			Backus Bros., South Windham.	33.00
			Arnold Rudd, New London.	34.00
			W. C. Reynolds, Goodspeeds.	33.00
			D. N. Clark, Shelton.	38.00
			F. H. & F. W. Tillinghast, Central Village.	32.00
			H. L. Vibberts, Manchester.	35.00
			D. G. Penfield, Danbury.	35.00
			J. P. Barstow & Co., Norwich.	32.00
			W. T. Andrew, Orange.	----
			I. W. Denison, Mystic.	32.00
			F. P. Burr & Co., Middletown.	32.00
			H. S. Hall, 2d, Wallingford.	38.00
3233	Pelican Bone Fertilizer.	H. J. Baker & Bro., 215 Pearl St., New York.	Rodgers Bros., New London.	32.50
			E. J. Dickerman, Mt. Carmel.	32.50
3247	Sea Fowl Guano.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	F. S. Bidwell, Windsor Locks.	33.00
3304	Soluble Pacific Guano.	W. D. Stewart & Co., 7 Exchange Place, Boston, Mass.	John Bransfield, Portland.	38.00
			R. H. Tucker, Saybrook.	35.00
			L. J. Grant, South Windsor.	36.00
			Edward Halladay, Suffield.	36.00
			W. F. Andross, E. Hartford.	36.00
			P. J. Bolan, Waterbury.	35.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3318	Ammoniated Bone Fertilizer.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. E. Leonard, Jewett City.	$32.00
			E. M. Brewster, Norwich.	32.00
			N. E. Smith, Woodmont.	30.00
			Waldo Tillinghast, Plainfield.	33.00
			Strong & Backus, Colchester.	31.00
3299	Vegetable Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	J. E. Holmes, Ridgefield.	44.00
3246	Fish and Potash, Triangle A Brand.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	G. W. Grant, South Windsor.	32.00
			R. A. Parker, Warehouse Point.	30.00
			D. N. Clark, Shelton.	40.00
			Carter & Strong, Manchester.	33.00
3317	Hill and Drill Phosphate.	Bowker Fertilizer Co., Boston, Mass.	J. M. Williams, Manchester.	38.00
			M. A. Covell, North Grosvenordale.	34.00
			E. F. Miller, Ellington.	34.00
			City Coal & Wood Co., New Britain.	36.00
			J. H. Fish, Newington.	36.00
			W. F. Andross, E. Hartford.	37.00
			B. Curtiss & Son, Stepney.	37.00
			J. H. Larned, Pomfret.	36.00
			M. McNamara, New Milford.	36.00
			E. M. Brewster, Norwich.	38.00
			F. Hallock & Co., Birmingham.	34.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3297	Ammoniated Bone Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	Prindle & Clark, W. Cheshire.	----
			H. C. Aborn, Ellington.	$34.00
			G. W. Clark, Milford.	----
			F. N. Barton, Watertown.	36.00
			J. P. Little, Columbia.	37.00
			E. W. Peck, Stratford.	38.00
			John Bransfield, Portland.	----
			H. L. Vibberts, Manchester.	37.00
			C. A. Young, Danielsonville.	36.00
			J. E. Leonard, Jewett City.	35.00
3245	Fish and Potash, Anchor Brand.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	H. C. Aborn, Ellington.	30.00
3311	Fish and Potash, Plain Brand.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	A. J. Martin, Wallingford.	27.00
			M. O. Babcock, Branford.	32.00
3264	High Grade Farmer's Friend Fertilizer.	Read Fertilizer Co., Box 3121, New York.	Prior & Tryon, Middletown.	40.00
			Howard Ives, Cheshire.	42.00
3229	Alkaline Bone.	E. Frank Coe, 16 Burling Slip, New York.	Backus Bros., South Windham.	30.00
			C. H. Lounsbury, Seymour.	32.00
3308	Pine Island Phosphate.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	Olin Wheeler, South Windsor.	----
			Olds & Whipple, Hartford.	35.00

NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3303	New Rival Phosphate.	Crocker Fertilizer Co., Buffalo, New York.	W. L. L. Spencer, Lebanon.	$32.00
			J. A. Weed, New Canaan.	40.00
			M. A. Covell, North Grosvenordale.	32.00
			F. N. Barton, Watertown.	32.00
3230	Gold Brand Excelsior Guano.	E. Frank Coe, 16 Burling Slip, New York.	D. G. Penfield, Danbury.	40.00
			J. Amidon, Wethersfield.	39.00
			Arnold Rudd, New London.	40.00
3256	Fish and Potash.	Read Fertilizer Co., Box 3121, New York.	Howard Ives, Cheshire.	30.00
			Prior & Tryon, Middletown.	28.00
3263	Standard Phosphate.	Read Fertilizer Co., Box 3121, New York.	Prior & Tryon, Middletown.	30.00
			Howard Ives, Cheshire.	32.00
3330	Special Favorite Fertilizer.	Davidge Fertilizer Co., 121 Front St., New York.	J. M. Burke, South Manchester.	34.00
			Waldo Tillinghast, Plainfield.	37.00
3310	Fish and Potash, Crossed Fishes Brand.	Quinnipiac Co., Boston, Mass.	M. A. Covell, North Grosvenordale.	30.00
			M. O. Babcock, Branford.	36.00
			Olin Wheeler, South Windsor.	----
			J. F. Silliman, New Canaan.	38.00
			Olds & Whipple, Hartford.	36.00
3328	Royal Bone Phosphate.	Williams & Clark Fertilizer Co., 83 Fulton St., New York.	John Bransfield, Portland.	30.00
			Dale, Day & Co., South Manchester.	30.00
3358	Acme Fertilizer, No. 2.	Acme Fertilizer Co., Maspeth, L. I.	D. R. Hubbard, Guilford.	45.00
3287	Economical Bone Fertilizer.	Wilkinson & Co, 81 Fulton St., New York.	W. H. Harris, Woodstock.	32.00
3301	Practical Ammoniated Bone Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	W. L. L. Spencer, Lebanon.	31.00

Analyses of Nitrogenous Superphosphates Sampled by the Station.

Station No.	Name or Brand.	Nitrogen					Phosphoric Acid.							Potash.					
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found	Available. Guaranteed.	Found.	Guaranteed.	Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
3183	L. Wilcox's Acidulated Fish Guano	....	.80	4.95	5.75	....	1.42	2.58	.63	4.63	....	4.00	....	....	....	....	$20.00	$24.67	*18.9
3136	L. Sanderson's Dry Ground Fish	....	....	8.59	8.59	*6.6*	.75	3.37	2.98	7.10	*6.0*	4.12	....	....	....	....	30.00	34.08	*11.9
3344	Mapes' Pure Fine Dissolved Bone	....	....	2.82	2.82	*2.1*	4.88	12.19	2.36	19.43	....	17.07	*12.0*	....	....	....	32.00	35.79	*10.6
3172	L. Wilcox's Dry Ground Fish Guano	....	....	8.90	8.90	*8.0*	.67	3.43	3.09	7.19	*6.0*	4.10	*4.0*	....	....	....	32.00	35.04	*8.6
3253	Church's Dry Ground Menhaden Guano	....	....	8.68	8.68	*8.2*	.59	3.84	3.10	7.53	*8.0*	4.43	....	....	....	....	34.00	34.85	*2.5
3234	Cumberland BoneSuperphosphate	.30	....	2.25	2.55	*2.5*	5.79	7.18	1.81	14.78	....	12.97	*12.0*	2.25	*3.0*	1.29	30.00	30.74	*2.4
3257	Bradley's Dry Ground Fish	....	....	8.57	8.57	*7.4*	.61	3.64	3.36	7.61	*7.0*	4.25	....	....	....	....	34.50	34.36	.4
3232	Kelsey's Bone, Fish and Potash	....	.74	3.41	4.15	*3.3*	3.07	2.10	.38	5.55	*4.0*	5.17	....	3.00	*3.0*	.22	25.00	24.76	1.0
3220	Sanderson's Formula A	1.08	.69	2.43	4.20	*3.3*	6.69	3.48	.15	10.32	*10.0*	10.17	*6.0*	5.54	*6.0*	4.32	35.00	34.18	2.4
3213	Quinnipiac Co.'s Dry Ground Fish	....	.26	8.33	8.59	*7.4*	.48	4.15	2.60	7.23	*7.0*	4.63	*4.0*	....	....	....	36.00	34.82	3.3
3231	Chittenden's Fish and Potash	....	.46	4.38	4.84	*3.3*	3.60	2.79	1.31	7.70	*6.0*	6.39	....	6.13	*5.0*	4.91	32.50	31.27	3.9
3255	Church's Standard C Brand Fertilizer	....	.32	3.70	4.02	*3.3*	6.80	2.64	.92	10.36	*10.0*	9.44	....	4.11	*4.0*	1.68	35.00	31.94	9.6
3254	Church's Special B Brand	....	....	6.06	6.06	*4.9*	3.46	2.91	1.42	7.79	*12.0*	6.37	....	4.93	*6.0*	5.40	37.00	33.71	9.7

* Valuation exceeds cost.

Analyses of Nitrogenous Superphosphates Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.					Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.	Chlorine.	Cost per Ton.	Valuation per Ton.	
3336	Shoemaker's Swift Sure Superphosphate	.80	....	2.25	3.05	*2.5*	7.38	4.36	2.40	14.14	*14.0*	11.74	*9.0*	4.76	*4.0*	none	$38.00	$33.85	12.2
3321	Mapes' Genuine Peruvian Guano	....	1.83	.97	2.80	*3.3*	3.38	8.92	9.90	22.20	*23.0*	12.30	....	3.09	*3.0*	2.03	41.00	35.39	15.9
3291	Mapes' Complete Manure, A Brand	.64	.60	1.79	3.03	*2.5*	8.48	2.86	1.63	12.97	*12.0*	11.34	*10.0*	3.21	*2.5*	3.04	36.00	31.03	16.0
3288	Mapes' Complete Manure for General Use	.62	1.00	2.06	3.68	*3.3*	6.72	3.54	1.38	11.64	....	10.26	*8.0*	4.42	*4.0*	2.47	38.00	32.70	16.2
3324	Chittenden's Ammoniated Bone Phosphate	....	....	2.52	2.52	*1.7*	6.88	3.75	1.95	12.58	*9.0*	10.63	*7.0*	2.58	*2.0*	1.25	33.00	27.73	19.0
3248	Bradley's Farmers' New Method Fertilizer	....	....	2.38	2.38	*1.7*	7.20	2.97	1.95	12 12	*10.0*	10.17	*8.0*	3.03	*3.0*	2.75	32.00	26.87	19.1
3235	Baker's A.A. Ammoniated Superphosphate	trace	1.85	.96	2.81	*2.5*	10.51	1.27	.38	12.16	*11.0*	11.78	*10.0*	2.83	*2.0*	3.86	37.50	31.25	20.0
3262	Lister's Standard Phosphate	....	.46	2.07	2.53	*2.1*	7.89	4.14	2.45	14.48	*12.0*	12 03	*10.0*	1.09	*1.5*	.23	35.00	29.07	20.4
3174	Wilcox's High Grade Fish and Potash	....	.45	3.45	3.90	*3.3*	3.52	2.17	.73	6.42	*6.0*	5.69	*5.0*	4.63	*4.0*	7.74	31.00	25.70	20.7
3334	Reese's Pilgrim Fertilizer	....	....	1.53	1.53	*1.0*	2.88	8.04	.40	11.32	*7.5*	10.92	*6.5*	2.51	....	2.23	29.00	23.83	21.7
3175	Wilcox's Ammoniated Bone Phosphate	....	.39	3.47	3.86	*3.3*	4.19	2.16	.74	7.09	*7.0*	6.35	*6.0*	5.32	*5.0*	6.21	33.00	27.12	21.7
3312	Darling's Animal Fertilizer	.38	....	3.31	3.69	*3.3*	4.54	3.57	1.54	9.65	*10.0*	8.11	....	5.47	*4.0*	5.30	36.00	29.52	21.9
3333	Reese's New England Favorite	....	....	2.72	2.72	*2.4*	4.03	6.23	.37	10.63	*11.0*	10.26	*9.0*	1.84	*2.0*	2.33	32.00	26.04	22.9
3306	Quinnipiac Phosphate	.08	....	2.97	3.05	*2.5*	6.81	3.73	1.66	12.20	*10.0*	10.54	*9.0*	1.99	*2.0*	1.88	35.00	28.39	23.3
3241	Bradley's Superphosphate	.18	....	2.59	2.77	*2.5*	7.82	3.17	1.36	12.35	*11.0*	10.99	*9.0*	2.20	*2.0*	2.65	35.00	28.34	23.5

Analyses of Nitrogenous Superphosphates Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3227	Church's Fish and Potash	....	....	4.18	4.18	*3.3*	1.31	2.92	.96	5.19	*5.0*	4.23	....	3.09	*3.0*	5.44	$28.00	$22.60	23.9
3225	Americus Ammoniated Bone Phosphate	.08	....	2.75	2.83	*2.5*	7.28	3.73	.72	11.73	*10.0*	11.01	*9.0*	2.04	*2.0*	1.58	35.00	28.14	24.4
3309	Quinnipiac Market Garden Phosphate	.26	.64	2.48	3.38	*3.3*	6.03	1.95	.50	8.48	*9.0*	7.98	*8.0*	7.83	*7.0*	1.27	40.00	31.86	25.5
3323	Chittenden's Complete Fertilizer	.57	....	2.77	3.34	*3.3*	4.56	5.80	2.56	12.92	*8.0*	10.36	*6.0*	6.22	*6.0*	5.81	41.50	32.86	26.3
3325	Reese's Mayflower Fertilizer	....	....	2.02	2.02	*1.8*	3.25	7.62	.45	11.32	*10.0*	10.87	*8.5*	1.57	*2.3*	3.30	31.00	24.48	26.6
3328	E. F. Coe's High Grade Phosphate	...	.60	1.72	2.32	*2.0*	7.87	2.22	2.05	12.14	*11.0*	10.09	*9.0*	2.41	*3.0*	.40	34.00	26.84	26.7
3333	Baker's Pelican Bone Fertilizer	....	1.27	.91	2.18	*1.8*	8.46	1.19	.26	9.91	*9.0*	9.65	*8.0*	2.85	*2.3*	6.18	32.50	25.53	27.3
3247	Bradley's Sea Fowl Guano	....	....	2.42	2.42	*2.5*	6.90	2.92	1.93	11.75	*11.0*	9.82	*9.0*	2.41	*2.0*	2.22	33.00	25.87	27.5
3304	Stewart's Soluble Pacific Guano	.11	.23	2.44	2.78	*2.3*	7.13	2.69	1.52	11.34	*10.5*	9.82	*8.5*	2.76	*2.0*	2.00	35.00	27.30	28.2
3318	Bowker's Ammoniated Bone Fertilizer	.58	....	1.63	2.21	*2.0*	7.30	2.38	1.62	11.30	*10.0*	9.68	*8.0*	2.05	*2.0*	3.09	32.00	24.48	30.7
3299	Crocker's Vegetable Phosphate	....	.12	4.85	4.97	*5.0*	4.56	2.00	1.13	7.69	*7.0*	6.56	*6.0*	8.24	*6.0*	7.88	44.00	33.65	30.7
3246	Bradley's Fish and Potash, Triangle A Brand	....	....	2.97	2.97	*2.0*	4.50	2.02	1.66	8.18	*6.0*	6.52	*4.0*	3.75	*4.0*	5.10	31.00	23.49	32.0
3317	Bowker's Hill and Drill Phosphate	.87	....	1.97	2.84	*2.5*	8.00	2.48	1.76	12.24	*12.0*	10.48	*8.0*	2.37	*2.0*	2.29	37.00	27.98	32.2
3297	Crocker's Ammoniated Bone Phosphate	...	....	2.88	2.88	*2.9*	5.17	5.07	2.66	12.90	*11.0*	10.24	*10.0*	.93	*1.0*	1.46	35.50	26.71	32.9

Analyses of Nitrogenous Superphosphates Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.			Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.	Chlorine.			
3245	Bradley's Fish and Potash, Anchor Brand	....	....	3.53	3.53	*2.2*	2.99	2.97	2.18	8.14	*5.0*	5.96	*3.0*	3.29	*3.0*	5.32	$32.00	$24.01	33.5
3311	Quinnipiac Fish and Potash, Plain Brand	....	....	2.87	2.87	*2.0*	3.23	2.39	1.26	6.88	*6.0*	5.62	*4.0*	3.81	*4.0*	6.40	29.00	21.60	34.2
3264	Read's High Grade Farmer's Friend	....	....	3.22	3.22	*3.3*	4.24	1.90	1.18	7.32	....	6.14	*5.0*	9.95	*10.0*	7.46	40.00	29.05	37.6
3229	E. Frank Coe's Alkaline Bone	....	....	1.07	1.07	*1.0*	7.56	2.99	1.73	12.28	*9.0*	10.55	*9.0*	1.74	*3.0*	.25	31.00	22.44	38.1
3308	Quinnipiac Pine Island Phosphate	....	.23	2.36	2.59	*2.1*	6.02	2.97	1.15	10.14	*10.0*	8.99	*9.0*	1.37	*1.0*	1.39	34.00	23.95	41.9
3303	Crocker's New Rival Phosphate	....	....	1.51	1.51	*1.2*	6.06	3.89	1.82	11.77	*11.0*	9.95	*10.0*	1.41	*1.6*	2.40	32.00	22.22	44.0
3230	E. F. Coe's Excelsior Guano, Gold Brand	....	1.27	1.04	2.31	*2.5*	6.45	2.68	1.94	11.07	*9.0*	9.13	*8.0*	4.75	*6.0*	1.79	40.00	27.79	43.9
3256	Read's Fish and Potash	....	....	2.59	2.59	*2.5*	3.39	1.66	.77	5.82	*6.0*	5.05	*4.0*	4.30	*4.0*	5.86	29.00	20.12	44.1
3263	Read's Standard Phosphate	trace	....	1.13	1.13	*0.8*	7.20	1.40	.51	9.11	*10.0*	8.60	*8.0*	4.23	*4.0*	6.28	31.00	21.14	46.6
3330	Davidge Special Favorite	....	....	1.64	1.64	*1.2*	8.35	2.59	.19	11.13	*11.0*	10.94	*10.0*	1.60	*1.5*	1.52	35.00	23.86	46.7
3310	Quinnipiac Fish and Potash, Crossed Fishes Brand	....	....	3.43	3.43	*3.3*	2.88	2.61	1.79	7.28	*5.0*	5.49	*3.0*	3.64	*3.0*	5.80	34.00	23.16	46.8
3328	Williams & Clark's Royal Bone Phosphate	....	....	1.09	1.09	*1.0*	6.56	2.60	1.15	10.31	*8.0*	9.16	*7.0*	1.71	*2.0*	.85	30.00	19.90	50.8
3358	Acme Fertilizer, No. 2	....	2.55	1.47	4.02	*4.9*	3.92	2.20	2.85	8.97	*8.0*	6.12	....	4.88	*5.0*	4.45	45.00	29.09	54.7
3227	Wilkinson's Economical Bone Fertilizer	....	....	1.07	1.07	*2.1*	4.70	2.15	.67	7.52	*6.0*	6.85	....	2.67	*3.0*	5.60	27.00	16.74	61.5
3301	Crocker's Practical Ammoniated Bone Phosphate	....	....	.73	.73	*0.8*	5.69	3.43	1.95	11.07	*9.0*	9.12	*8.0*	1.41	*1.0*	1.39	31.00	18.56	67.0

Fish and Potash.

On page 59 the different brands of Fish and Potash are tabulated by themselves, though they are also included in the tables of nitrogenous superphosphates on pages 44 to 57.

They contain from 2.6 to 4.8 per cent. of nitrogen, 5.2 to 8.2 per cent. of phosphoric acid and from 3.0 to 6.0 per cent. of potash.

The following two analyses are not included in the tables of superphosphates already given.

3202. Read's Standard Fertilizer. Sample drawn by M. S. Baldwin, Naugatuck, from stock of Frank Truesdell, Naugatuck.

3319. Bristol Fish and Potash. Made by Bowker Fertilizer Co., Boston. Sampled by Station agent from stock of E. M. Brewster, Norwich, and B. Curtiss & Sons, Stepney.

The manufacturers state that not over five tons of this brand—which is totally distinct from their "Bowker's Fish and Potash"—were shipped into Connecticut this year, and that the brand has been withdrawn from the State.

Analyses.

	3202	3319
Nitrogen, organic	.97	1.13
Soluble phosphoric acid	6.40	7.54
Reverted " "	2.37	2.24
Insoluble " "	1.21	2.62
Potash	3.88	1.17
Chlorine	6.07	1.59
Cost per ton	$35.00	----
Valuation per ton	$20.78	21.03

2. *Manufacturers' Samples.*

3342. Original Coe's Superphosphate, made by Bradley Fertilizer Co., Boston, Mass.

3375. Buffalo Superphosphate, No. 2, made by Crocker Fertilizer Co., Buffalo, N. Y.

3376. Niagara Phosphate, made by Crocker Fertilizer Co., Buffalo, N. Y.

3377. Queen City Phosphate, made by Crocker Fertilizer Co., Buffalo, N. Y.

3337. Extra Bone Phosphate, made by L. B. Darling Fertilizer Co., Pawtucket, R. I.

FISH AND POTASH.—SAMPLED BY THE STATION.

	Kelsey's.	Chittenden's.	Wilcox's.	Church's.	Bradley's Triangle A.	Bradley's Anchor Brand.	Quinnipiac Plain Brand.	Read's.	Quinnipiac Crossed Fishes Brand.
	3232	3331	3174	3227	3246	3245	3311	3256	3310
Nitrogen as Ammonia	.74	.46	.45	....	....	....	....	....	....
Nitrogen, Organic	3.41	4.38	3.45	4.18	2.97	3.53	2.87	2.59	3.43
Soluble Phosphoric Acid	3.07	3.60	3.52	1.31	4.50	2.99	3.23	3.39	2.88
Reverted Phosphoric Acid	2.10	2.79	2.17	2.92	2.02	2.97	2.39	1.66	2.61
Insoluble Phosphoric Acid	.38	1.31	.73	.96	1.66	2.18	1.26	.77	1.79
Potash	3.00	6.13	4.63	3.09	3.75	3.29	3.81	4.30	3.64
Cost	$25.00	$32.50	$31.00	$28.00	$31.00	$32.00	$29.00	$29.00	$34.00
Valuation	24.76	31.27	25.70	22.60	23.49	24.01	21.60	20.12	23.16

3340. Ammoniated Dissolved Bone Phosphate, made by Lister's Agricultural Chemical Works, Newark, N. J.

3338. IXL Ammoniated Bone Superphosphate, made by the Miles Fertilizer & Oil Co., Milford, Conn.

III. Special Manures.

1. *Sampled by Station Agents.*

For Analyses and Valuations see pages 62 to 73.

Here are included such Nitrogenous Superphosphates as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

Guarantees.

Eleven brands are below the maker's guarantee in respect of one ingredient, two in respect of two ingredients, and one brand is below in all three.

Actual Composition.

Below are given the highest and lowest percentage of each ingredient found in any special manure as well as their average composition.

Composition of Special Manures.

	Highest.	Lowest.	Average.
Nitrogen as nitrate	5.08	none.	.62
" " ammonia	3.90	none.	.85
" organic	3.90	none.	2.25
Total nitrogen	6.90	1.15	3.72
Soluble Phosphoric Acid	7.65	none.	5.05
Reverted " "	9.16	1.13	2.77
Insoluble " "	7.56	.11	1.57
Readily available Phosph. Acid	10.36	4.38	7.82
Total	16.72	5.36	9.39
Potash	11.66	1.54	6.74
Cost per ton	$50.00	$33.00	$38.84
Valuation per ton	$46.35	$21.42	$31.64

A comparison of the average composition of these special manures with that of the other nitrogenous superphosphates shows the former to contain, on the whole, considerably more nitrogen, nearly twice as much potash and somewhat less phosphoric acid than the latter.

Cost, Valuation and Percentage Difference.

The average cost per ton of the special manures has been $38.84, the average valuation, $31.64 and the percentage difference 22.8, a little higher than in case of the nitrogenous superphosphates.

Last year the corresponding figures were: Average cost $39.18, average valuation $32.90, percentage difference 19.0.

Manufacturer's Samples—Analyses and Valuations.

	3342	3375	3376	3377	3337	3340	3338
Nitrogen as nitrates	----	----	----	----	.58	----	----
Nitrogen as ammonia	----	----	----	----	----	.42	.29
Nitrogen, organic	2.60	----	----	1.98	3.34	2.18	2.03
Total nitrogen found	2.60	----	----	1.98	3.92	2.50	2.32
Nitrogen guaranteed	**2.1**	----	----	**1.7**	----	**1.8**	----
Soluble phosphoric acid	6.91	10.66	10.59	8.70	4.19	7.45	7.92
Reverted phosphoric acid	5.15	2.87	2.90	2.68	4.89	4.14	1.75
Insoluble phosphoric acid	1.61	trace	2.69	.21	1.74	2.64	.03
Total phosphoric acid found	13.65	13.53	16.18	11.59	10.82	14.23	9.70
Phosphoric acid guaranteed	**10.0**	**12.0**	**12.5**	----	----	**11.0**	----
Available phosphoric acid found	12.04	13.53	13.49	11.38	9.08	11.59	9.67
Available phosphoric acid Guaranteed	**8.0**	**11.0**	**11.5**	**8.0**	----	**9.0**	----
Potash	1.43	2.78	----	2.03	3.96	1.60	1.72
Potash guaranteed	**1.0**	**1.4**	----	**1.0**	----	**1.5**	----
Chlorine	1.77	3.14	----	1.82	1.11	----	1.64
Valuation per ton	$28.74	23.87	22.37	25.99	30.84	29.27	24.22

Special Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3260	Fairchild's Formula for Corn and General Crops.	Rogers & Hubbard Co., Middletown, Conn.	Strong & Backus, Colchester.	$44.00
3322	Seeding Down Manure.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes' Conn. Valley Branch, Hartford.	37.50
3314	Stockbridge Manure for Tobacco.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	H. K. Brainard, Thompsonville.	50.00
3287	Grass and Grain Spring Top Dressing.	Mapes' Formula & Peruvian Guano Co., New York.	F. S. Bidwell, Windsor Locks.	40.00
			Strong & Backus, Colchester.	39.00
			G. K. Nason, Willimantic.	39.00
			Mapes' Conn. Valley Branch, Hartford.	39.00
			Soule & Staub, New Milford.	41.00
3289	Manure for Fruit and Vines.	Mapes' Formula & Peruvian Guano Co., New York.	Mapes' Conn. Valley Branch, Hartford.	38.00
			E. N. Pierce & Co., Plainville.	40.00
3259	Soluble Potato Manure.	Rogers & Hubbard Co., Middletown, Conn.	A. E. Kilburn, East Hartford.	37.00
			G. L. Foskett, Winsted.	37.00
			City Coal & Wood Co., New Britain.	37.00
			Strong & Backus, Colchester.	36.00
			Daniel Moriarty, South Meriden.	37.00
3292	Complete Manure for Light Soils, or Vegetable Manures.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes' Conn. Valley Branch, Hartford.	42.00
			Wilson & Burr, Middletown.	43.00
			G. K. Nason, Willimantic.	42.00
			Birdsey & Foster, Meriden.	42.00
			J. P. Barstow & Co., Norwich.	43.00
3173	Potato Manure.	Leander Wilcox, Mystic, Conn.	Manufacturer.	34.00
			J. M. Young, Norwich.	35.00
			W. C. Reynolds, Goodspeeds.	32.00
			C. M. Smith, East Hartford.	36.00
			J. A. Lewis, Willimantic.	30.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3171	C. C. C. Special Potato Manure.	Chemical Co. of Canton, Baltimore, Md.	G. L. Foskett, Winsted.	$35.00
3240	High Grade Tobacco Manure.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	A. C. Sternberg, Hartford.	46.00
3261	Lister's Potato Fertilizer.	Lister's Agricultural Chemical Works, Newark, N. J.	E. P. Carroll, East Hartford.	37.00
3332	Concentrated Potato and Corn Manure.	J. S. Reese & Co., 10 Broad St., Baltimore, Md.	H. F. Standish, Andover.	34.00
			Montgomery & Co., Groton.	32.00
3239	Special Tobacco Manure.	H. J. Baker & Bro., 215 Pearl St., New York.	E. F. Hawley, Newtown.	42.00
			L. J. Grant, South Windsor.	40.00
3285	Corn Manure.	Mapes' Formula & Peruvian Guano Co., New York.	F. S. Bidwell, Windsor Locks.	40.00
			W. W. Cooper, Suffield.	41.00
			D. B. Wilson, Watertown.	41.00
			G. K. Nason, Willimantic.	39.00
			W. A. Benton, Guilford.	40.00
			Mapes' Branch, Hartford.	39.00
			W. R. Foote, Branford.	40.00
			Southington Lumber & Feed Co., Southington.	40.00
			E. N. Pierce & Co., Plainville.	40.00
3286	Corn Manure.	Mapes' Formula & Peruvian Guano Co., New York.	D. Beers, Danbury.	39.00
3290	Tobacco Manure, Conn. Brand.	Mapes' Formula & Peruvian Guano Co., New York.	Mapes' Branch, Hartford.	44.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3243	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., Boston, Mass	J. F. Ellwood, Southport.	$38.00
			R. A. Parker, Warehouse Point.	36.00
			Strong & Tanner, Winsted.	40.00
			J. A. Lewis, Willimantic.	40.00
			W. H. Cheney's Sons, South Manchester.	42.00
			Dix & Welles, Wethersfield.	40.00
			City Coal & Wood Co., New Britain.	41.00
			Carter & Strong, Manchester.	42.00
3238	Potato Manure.	H. J. Baker & Bro., 215 Pearl St., New York.	E. F. Hawley, Newtown.	42.50
			H. L. Foote, Brookfield Junction.	42.00
			J. H. Ives, Danbury.	42.00
			A. L. Winton, Bridgeport.	42.00
			E. H. Talcott, Torrington.	42.00
			Rodgers Bros., New London.	40.50
			W. F. Andross, East Hartford.	40.00
			E. J. Dickerman, Mt. Carmel.	42.50
3236	Tobacco Manure, Wrapper Brand.	Mapes' Formula & Peruvian Guano Co., New York.	Mapes' Branch, Hartford.	48.00
			Southington Lumber & Feed Co., Southington.	47.50
			F. S. Bidwell, Windsor Locks.	49.00
			Soule & Staub, New Milford.	50.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3293	Potato Manure.	Mapes' Formula & Peruvian Guano Co., New York.	W. R Foote, Branford.	$42.00
			F. S. Bidwell, Windsor Locks.	42.00
			Quinnebaug Store, Danielsonville.	43.00
			Wheeler & Howe, Bridgeport.	45.00
			C. W. Beardsley, Milford.	42.00
			Southington Lumber & Feed Co., Southington.	40.50
			E. N. Pierce & Co., Plainville.	42.00
			Wilson & Burr, Middletown.	42.00
			A. N. Clark, Milford.	43.00
			Soule & Staub, New Milford.	43.00
			Mapes' Branch, Hartford.	41.00
			Strong & Backus, Colchester.	41.00
			J. P. Barstow & Co., Norwich.	42.00
			Raymond Bros., South Norwalk.	43.00
			Abbott & Co., Birmingham.	40.00
			D. B. Wilson, Waterbury.	43.00
3313	Potato and Root Crop Manure.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	City Coal & Wood Co., New Britain.	38.00
3327	High Grade Special for Potatoes, Tobacco, Onions and Cabbage.	Williams & Clark Co., 83 Fulton St., New York.	John Bransfield, Portland.	40.00
			Hale. Day & Co., South Manchester.	40.00
			L. J. Grant, South Windsor.	40.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3279	Great Eastern Vegetable, Vine and Tobacco Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	W. A. Bonfoey, Higganum.	$35.00
			S. D. Woodruff, Orange.	35.00
			F. W. Goodrich, Portland.	----
			Wm. Burr & Son, Fairfield.	34.00
			Way & Sanderson, Pomfret.	36.00
			G. H. Law, Killingly.	32.00
3315	Stockbridge Manure for Corn	Bowker Fertilizer Co., Boston, Mass.	Waldo Tillinghast, Plainfield.	40.00
			Lewis Browning, New London.	42.50
			E. J. Dickerman, Mt. Carmel.	43.00
			J. A. Lewis, Willimantic.	40.00
			J. A. Paine, Danielsonville.	40.00
			A. H. Anderson, Putnam.	42.00
			H. E. Mead, Ridgefield.	45.00
			E. F. Miller, Ellington.	38.00
			W. A. Beers, Brookfield Junction.	----
			J. H. Larned, Pomfret.	42.00
			City Coal & Wood Co., New Britain.	41.00
			J. M. Williams, Manchester.	40.00
3300	Special Potato Manure.	Crocker Fertilizer Co., Buffalo, N. Y.	F. H. & F. W. Tillinghast, Central Village.	40.00
			H. L. Vibberts, Manchester.	40.00
			Waldo Tillinghast, Plainfield.	37.00
			E. W. Peck, Stratford.	40.00
			G. W. Clark, Milford.	----
			City Coal & Wood Co., New Britain.	39.00
			E. J. Dickerman, Mt. Carmel.	41.00
			Prindle & Clark, West Cheshire.	37.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3278	Great Eastern Grain and Grass Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	Wm. Burr & Son, Fairfield.	$33.00
			W. A. Snow, Columbia.	35.00
			G. H. Law, Killingly.	32.00
			Way & Sanderson, Pomfret.	36.00
3244	Complete Manure for Corn and Grain.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Carter & Strong, Manchester.	42.00
			J. E. Holmes, Stratford.	40.00
			D. N. Clark & Sons, Milford.	38.00
3316	Stockbridge Manure for Potatoes and Vegetables.	Bowker Fertilizer Co., Boston, Mass.	F. S. Bidwell, Windsor Locks.	42.00
			Southington Lumber & Feed Co., Southington.	40.50
			A. S. Russell & Co., Meriden.	45.00
			E. B. Clark, Milford.	39.00
			E. J. Dickerman, Mt. Carmel.	43.00
			City Coal & Wood Co., New Britain.	41.00
			N. E. Smith, Woodmont.	40.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3298	Potato, Tobacco and Hop Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	H. T. Hart, Burnside.	$36.00
			J. E. Leonard, Jewett City.	35.00
			W. L. L. Spencer, Lebanon.	38.00
			M. H. Aborn & Co., Rockville.	34.00
			E. W. Peck, Stratford.	37.00
			F. N. Barton, Watertown.	36.00
			G. W. Clark, Milford.	----
			W. C. Russell, Orange.	33.00
			J. A. Weed, New Canaan.	37.00
			J. P. Little, Columbia.	38.00
3305	Soluble Pacific Potato Fertilizer.	W. D. Stewart & Co., 7 Exchange Place, Boston, Mass.	P. J. Bolan, Waterbury.	35.00
			R. H. Tucker, Saybrook.	35.00
3357	Potato Fertilizer, Conn. Brand.	Acme Fertilizer Co., Maspeth, L. I.	D. R. Hubbard, Guilford.	38.00
3326	Potato Phosphate.	Williams & Clark Fertilizer Co., New York.	J. P. Kingsley, Plainfield.	33.00
			Chas. Kingsbury, South Coventry.	37.00
			Hale, Day & Co., South Manchester.	36.00
			Geo. Beaumont, Wallingford.	35.00
			Daniel Morgan, Mystic.	35.00
			L L. Dimmock, Waterford.	36.00
			Joseph Roode, Griswold.	36.00
			T. C. Smith, Torrington.	40.00
			H. L. Vibberts, Manchester.	38.00
			D. B. Wilson, Waterbury.	36.00
			H. K. Brainard, Thompsonville.	38.00
			A. H. Anderson, Putnam.	36.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3302	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer Co., Buffalo, N.Y.	F. N. Barton, Watertown.	$35.00
			M. H. Aborn & Co., Rockville.	34.00
			J. E. Leonard, Jewett City.	32.00
			Henry Davis, Durham.	32.00
			W. C. Russell, Orange.	33.00
			J. E. Holmes, Ridgefield.	35.00
			Prindle & Clark, West Cheshire.	----
			Waldo Tillinghast, Plainfield.	33.00
			G. W. Clark, Milford.	----
			F. H. & F. W. Tillinghast, Central Village.	34.00
			H. L. Vibberts, Manchester.	35.00
			W. L. L. Spencer, Lebanon.	36.00
			E. W. Peck, Stratford.	36.00
3307	Potato Manure.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	D. N. Medbury, Pomfret.	36.00
			F. S. Bidwell, Windsor Locks.	36.00
			M. A. Covell, North Grosvernordale.	34.00
			A. J. Martin, Wallingford.	35.00
			C. E. Young, Killingly.	35.00
			C. A. Young, Danielsonville.	38.00
			G. M. Williams, New London.	35.00
			Olds & Whipple, Hartford.	40.00
			J. S. Worthington, Gilderaleeve.	----
			D. C. Wood, Stratford.	38.00

SPECIAL MANURES SAMPLED BY THE STATION—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3242	Potato Manure.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Warner, Taylor & Curtiss, Sandy Hook.	$36.00
			J. S. Wells, Hebron.	39.00
			G. W. Carver, Putnam.	34.00
			H. C. Aborn, Ellington.	36.00
			A. C. Sternberg, Hartford.	36.00
			F. S. Bidwell, Windsor Locks.	36.00
			D. W. Spencer, Centerbrook.	38.00
			D. N. Clark, Shelton.	40.00
			J. E. Leonard, Jewett City.	37.00
			Samuel Stevens, North Glastonbury.	----
			City Coal & Wood Co., New Britain.	37.00
			Strong & Tanner, Winsted.	36.00
			W. F. Andross, Hartford.	36.00
			T. F. Powers, Waterford.	35.00
			Dix & Welles, Wethersfield.	35.00
			J. E. Holmes, Stratford.	38.00
			D. N. Clark & Sons, Milford.	34.00
			R. A. Parker, Warehouse Point.	35.00
3276	Samson Fertilizer for Vegetables and Potatoes.	Read Fertilizer Co., Box 3121, New York.	Howard Ives, Cheshire.	40.00
3258	Complete Manure for Top Dressing Grass and Grain.	Bradley Fertilizer Co., Boston, Mass.	G. W. Grant, South Windsor.	40.00
3277	Great Eastern Fertilizer for Oats, Buckwheat and Seeding Down.	Great Eastern Fertilizer Co., Rutland, Vt.	W. A. Snow, Columbia.	35.00
			Way & Sanderson, Pomfret.	34.00
			J. E. Comstock, New London.	32.00

Analyses of Special Manures Sampled by the Station.

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3260	Fairchild's Formula for Corn and General Crops	3.70	....	1.91	5.61	*5.5*	....	....	....	12.28	*12.0*	....	....	13.46	*12.0*	11.75	$44.00	†44.80	*1.8
3322	Mapes' Manure for Seeding Down	.83	....	2.76	3.59	*2.5*	....	9.16	7.56	16.72	*18.0*	9.16	....	11.43	*10.0*	10.35	37.50	38.03	1.4
3314	Stockbridge Manure for Tobacco	....	3.57	3.47	6.90	*5.7*	....	5.37	3.97	9.34	*5.0*	5.37	*4.0*	11.66	*10.0*	.39	50.00	46.35	7.8
3287	Mapes' Grass and Grain Spring Top Dressing	.99	1.52	2.60	5.11	*4.1*	6.45	2.36	.58	9.39	*7.0*	8.81	*7.0*	6.14	*5.0*	5.12	39.00	36.17	7.8
3289	Mapes' Manure for Fruit and Vines	.45	.89	1.63	2.97	*1.7*	5.65	2.41	1.15	9.21	*7.0*	8.06	*7.0*	11.45	*10.0*	.64	38.00	35.20	7.9
3259	Rogers & Hubbard's Soluble Potato Manure	1.57	....	3.90	5.47	*5.0*	1.14	5 68	3.32	10.14	*10.0*	6.82	....	5.17	*5.0*	.58	37.00	33.84	9.3
3292	Mapes' Complete Manure for Light Soils	1.44	1.65	2.15	5.24	*4.9*	6.27	2.57	.64	9.48	*8.0*	8.84	*7.0*	7.11	*6.0*	6.26	42.00	37.51	11.9
3173	Leander Wilcox's Potato Manure	.67	.25	2 63	3.55	*3.2*	6.19	1.16	.11	7.46	*8.0*	7.35	*7.0*	5.97	*6.0*	1.71	33.00	28.83	14.4
3171	C. C. C. Special Potato Manure	.58	....	2.27	2 85	*2.7*	6.08	1.22	.75	8.05	....	7.30	*6.0*	11.03	*9.0*	14.14	35.00	30.51	14.7
3240	Bradley's High Grade Tobacco Manure	....	3.53	2.53	6.06	*5 8*	2.03	2.35	1.38	5.76	*4.0*	4.38	....	11.02	*10.8*	1.30	46.00	40.01	15.0
3261	Lister's Potato Fertilizer	1.03	.74	2.25	4.02	*3.7*	6.61	1.34	.52	8.47	....	7.95	*7.5*	6.99	*7.0*	4.43	37.00	32.01	15.6
3332	Reese's Concentrated Potato and Corn Manure	trace	....	3.17	3.17	*3.0*	4.28	4.13	.29	8.70	*7.0*	8.41	*6.0*	6.14	*7.5*	6.48	33.00	28.53	15.7
3239	Baker's Special Tobacco Manure	....	3.90	.87	4.77	*4.5*	3.41	1.13	.82	5.36	....	4.54	*4.0*	9.87	*10.0*	.76	41.00	35.27	16.2

* Valuation exceeds cost

† A mixture of bone flour and chemicals. Phosphoric acid valued as in bone of same fineness.

Analyses of Special Manures Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrate.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3285	Mapes' Corn Manure	.84	.95	1.99	3.78	*3.7*	6.43	3.46	1.35	11.24	*10.0*	9.89	*8.0*	6.62	*6.0*	6.15	$40.00	$34.10	17.3
3286	Mapes' Corn Manure	.99	1.06	1.86	3.91	*3.7*	6.27	3.49	1.41	11.17	*10.0*	9.76	*8.0*	6.30	*6.0*	5.80	40.00	34.06	17.5
3290	Mapes' Tobacco Manure, Conn. Brand	.60	1.65	2.49	4.74	*4.7*	5.23	2.95	.67	8.85	....	8.18	*7.8*	8.08	*7.7*	1.00	44.00	37.28	18.0
3243	Bradley's Complete Manure for Potatoes and Vegetables	.33	1.23	2.20	3.76	*3.7*	7.01	1.90	1.45	10.36	*9.0*	8.91	*8.0*	5 36	*6.0*	5.95	38.00	31.78	19.5
3288	Baker's Potato Manure	.41	2.63	.88	3.92	*3.3*	4.91	1 62	.89	7.42	....	6.53	*5.0*	10.73	*10.0*	4.40	42.50	34.93	21.7
3286	Mapes' Tobacco Manure, Wrapper Brand	1.13	3.45	1.47	6.05	*6.2*	.72	3.96	1.75	6.43	*4.5*	4.68	*4.5*	10.36	*10.5*	1.31	48.00	39.44	21.7
3293	Mapes' Potato Manure	.89	.87	2.24	4.00	*3.3*	5.52	2.79	1.28	9.59	*8.0*	8.31	*8.0*	7.45	*6.0*	.54	42.00	34.32	22.4
3313	Darling's Potato and Root Crop Manure	.41	.34	3.16	3.81	*2.9*	2.85	4.80	2.78	10.43	....	7.65	*10.0*	6.46	*7.0*	5.25	38.00	30.93	22.9
3327	Williams & Clark's High Grade Special for Potatoes, Tobacco, Onions and Cabbage	.46	.85	2.30	3.61	*3.7*	5.60	3.35	1.92	10.87	*8.0*	8.95	*7 0*	6.63	*7.0*	6.79	40.00	32.34	23.7
3279	Great Eastern Vegetable, Vine and Tobacco Fertilizer	.17	....	2.08	2.25	*2.1*	6.40	1.97	1.16	9.53	*9.0*	8.37	*8.0*	6.29	*6.0*	6.00	34.00	26.26	29.4
3315	Bowker's Stockbridge Manure for Corn	1.37	....	1.95	3.32	*3.3*	7.52	2.49	1.50	11.51	*9.0*	10.01	*8.0*	4.31	*7.0*	4.03	40.00	30.27	32.1
3300	Crocker's Special Potato Manure	....	.19	3.27	3.46	*3.7*	6 59	1.16	1.14	8.89	*9.0*	7.75	*8.0*	6.47	*5.5*	6.16	39.00	29.40	32.7
3278	Great Eastern Grain and Grass Fertilizer	.23	....	2.78	3.01	*2.9*	6.88	1.78	.74	9.40	*9.0*	8.66	*8.0*	2.22	*2.0*	3.32	34.00	25.57	32.9

Analyses of Special Manures Sampled by the Station—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3244	Bradley's Complete Manure for Corn and Grain	.23	.49	2.35	3.07	*2.9*	7.65	2.71	1.03	11.39	*9.0*	10.36	*8.0*	3.71	*3.0*	3.93	$40.00	$29.83	34.1
3316	Stockbridge Manure for Potatoes and Vegetables	1.97	----	1.80	3.77	*3.3*	4.61	2.17	2.75	9.53	*8.0*	6.78	*7.0*	6.99	*5.0*	5.19	40.00	29.34	36.3
3298	Crocker's Potatoes, Tobacco and Hop Phosphate	----	----	2.25	2.25	*2.0*	6.80	2.93	1.87	11.60	*11.0*	9.73	*10.0*	3.41	*3.5*	3.80	36.00	26.08	38.0
3305	Stewart's Soluble Pacific Potato Fertilizer	----	----	2.82	2.82	*2.5*	4.75	2.35	1.92	9.02	*7.0*	7.10	*5.0*	5.23	*5.0*	4.92	35.00	25.35	38.0
3357	Acme Fertilizer Co's Conn. Brand for Potatoes	----	1.52	1.41	2.93	*3.3*	4.19	1.83	2.59	8.61	*7.0*	6.02	----	7.80	*7.0*	7.15	38.00	27.50	38.1
3326	Williams & Clark Fertilizer Co's Potato Phosphate	trace	----	2.87	2.87	*2.5*	5.23	2.48	1.12	8.83	*7.0*	7.71	*6.0*	5.02	*5.0*	3.81	36.00	25.96	38.7
3302	Crocker Ammoniated Wheat and Corn Phosphate	.05	----	2.10	2.15	*2.0*	7.15	2.81	1.92	11.88	*11.0*	9.96	*10.0*	1.54	*1.7*	2.45	34.00	24.48	38.9
3307	Quinnipiac Potato Manure	----	----	2.84	2.84	*2.5*	4.85	2.51	1.28	8.64	*7.0*	7.36	*6.0*	5.27	*5.0*	4.33	36.00	25.58	40.7
3242	Bradley's Potato Manure	.20	----	2.62	2.82	*2.5*	4.74	2.50	1.72	8.96	*8.0*	7.24	*6.0*	4.94	*5.0*	4.82	36.00	25.17	43.0
3276	Read's Samson Fertilizer for Vegetables and Potatoes	----	----	2.25	2.25	*2.5*	7.09	1.70	.67	9.46	*9.0*	8.79	*8.0*	6.84	*5.0*	6.28	40.00	27.30	46.5
3258	Bradley's Complete Manure for Top Dressing Grass and Grain	5.08	----	----	5.08	*5.0*	2.69	2.36	1.42	6.47	*6.0*	5.05	*5.0*	3.03	*2.5*	.40	40.00	26.37	51.6
3277	Great Eastern Fertilizer for Oats, Buckwheat and Seeding Down	trace	----	1.15	1.15	*.8*	7.20	1.44	.65	9.29	*9.0*	8.64	*8.0*	4.34	*4.0*	5.78	33.00	21.42	54.1

E. F. Coe's Potato Manure.

Below, No. **3231,** is given an analysis of this brand made on a mixture of equal parts of six samples drawn by our agents from stock of the following dealers: I. W. Denison, Mystic; W. C. Reynolds, Goodspeeds; H. L. Vibberts, Manchester; J. Amidon, Wethersfield; J. O. Fox & Co., Putnam; D. G. Penfield, Danbury.

The manufacturer objected that this analysis did not represent the quality of the goods shipped into Connecticut, and for this reason the analysis is here specially noted and not tabulated with the others. The sample is well above the manufacturer's guarantee in nitrogen and phosphoric acid but below in potash. The manufacturer claimed that it should show 6 per cent. actual potash, and believed that the sample might have been drawn by mistake from some other brand. It is inconceivable that the same mistake should have been made in six different places, but in order to see if the samples taken from the different dealers were nearly alike, nitrogen determinations were made separately in the six different samples.

The results in per cents. were as follows: 3.05, 2.05, 2.42, 2.18, 1.52, 2.05. A new mixture was now made, excluding the sample which had the lowest per cent. of nitrogen, 1.52, and analyzed with the results given under **3231A.**

	3231	3231A
Nitrogen in ammonia	.68	.74
Nitrogen, organic	1.58	1.70
Total nitrogen	2.26	2.44
Soluble phosphoric acid	6.75	6.40
Reverted " "	2.76	2.79
Insoluble " "	1.69	2.20
Total " "	11.20	11.39
Potash	4.09	3.80
Chlorine	1.38	.96

IV. Home Mixed Fertilizers.

Many farmers prefer to buy fertilizer-chemicals and mix them according to their own ideas of the requirements of their land and crops, and with the conviction that in the present state of the fertilizer trade they can buy nitrogen, phosphoric acid and potash more economically in this way than in any other.

The formulas of such home-mixtures as have been received at the Station and also the analyses are given in the tables on pages 76 to 80.

Since, in most cases, the stocks from which the chemicals were bought have been sampled and analyzed by the Station it is easy to calculate what the composition of the mixtures would have been if the goods had been perfectly uniform and the weighing and mixing accurate and thorough, without loss or gain of moisture.

This *calculated* composition is likewise given in the table.

The cost of the materials, *unmixed*, delivered at the purchaser's freight station is also given so far as could be ascertained.

The regular cash retail price of the materials is stated in nearly every case. Special and considerably reduced rates were obtained in a number of cases.

The valuations were calculated as in the preceding tables.

Calculated and Actual Composition.

The calculated nitrogen in most cases agrees fairly well with the amount actually found. There are greater discrepancies in phosphoric acid and potash; in most cases the actual phosphoric acid is less than calculated, and the potash more than calculated.

Average Composition of Home Mixtures.

	Highest.	Lowest.	Average.
Nitrogen as nitrate	2.95	none.	.82
" " ammonia	1.97	none.	.65
" organic	4.85	1.61	2.78
Total nitrogen	6.51	3.23	4.25
Soluble phosphoric acid	10.25	.16	4.72
Reverted " "	6.33	1.53	3.83
Insoluble " "	5.11	.55	2.53
Total " "	15.11	6.09	11.08
Potash	15.85	2.08	6.57
Cost of materials per ton unmixed	$39.60	$26.43	$34.82
Valuation per ton	$38.27	$30.28	$34.57

In the above table only those mixtures are regarded whose formulas are known.

Comparing the Home Mixtures with the Special Manures it is seen that the former contain on the average (fourteen analyses) half of a per cent. more nitrogen, over one and a half per cent. more phosphoric acid and slightly more of potash than the latter.

Cost, Valuation and Percentage Difference.

The average cost of the materials of which these mixtures were made, delivered, without the special discounts which were obtained in some cases, was $34.47. To this must be added the cost of screening and mixing which is necessarily variable and is estimated by those who have had experience, at from one to two dollars per ton.

If the average cost of the *mixed* materials is placed at $37.00 per ton it will probably fully cover all expense in every case.

On this basis

the average cost of the Home Mixtures has been $37.00, the average valuation $34.47 and the percentage difference 7.3.

Formulas of the Home Mixtures.

3125. Mixture made by S. E. Curtiss, Stratford.

Formula.

3,200	pounds	Dissolved Bone Black,	costing	$41.60
600	"	Double Sulphate of Potash,	"	9.00
600	"	Muriate of Potash,	"	12.75
800	"	Nitrate of Soda,	"	20.00
2,800	"	Tankage,	"	49.00
8,000				$132.35

3153. Mixture for general use made by N. D. Platt, Milford.

Formula.

1,335	pounds	Tankage,	costing	$24.03
1,333	"	Dissolved Bone Black,	"	17.32
333	"	Bone,	"	5.32
333	"	Sulphate of Ammonia,	"	11.98
333	"	Double Sulphate of Potash,	"	5.00
333	"	Muriate of Potash,	"	7.09
4,000				$70.74

Cost of materials $36.37 per ton delivered at Milford.

3154. Mixture for Potatoes made by Geo. F. Platt, Milford.

FORMULA.

800	pounds	Tankage,	costing	$14.40
400	"	Bone,	"	6.40
550	"	Dissolved Bone Black,	"	7.15
50	"	Sulphate of Ammonia,	"	1.80
100	"	Nitrate of Soda,	"	2.50
50	"	Double Sulphate of Potash,	"	.75
50	"	Muriate of Potash,	"	1.07
2,000				$34.07

Cost of materials $35.07 delivered at Milford.

3155. Mixture for Potatoes made by R. M. Treat, Woodmont.

FORMULA.

450	pounds	Tankage,	costing	$ 8.10
170	"	Sulphate of Ammonia,	"	6.12
1,000	"	Dissolved Bone Black,	"	13.00
280	"	Muriate of Potash,	"	5.96
100	"	Double Sulphate of Potash,	"	1.50
2,000				$34.68

Cost of materials $35.68 delivered at Woodmont.

3156. Mixture for Potatoes, made by Dennis Fenn, Milford.

FORMULA.

350	pounds	Muriate of Potash,	costing	$ 7.45
900	"	Dissolved Bone Black,	"	11.70
1,400	"	Tankage,	"	25.20
350	"	Nitrate of Soda,	"	8.80
3,000				$53.15

Materials cost $36.43 delivered at Milford.

3160. Mixture for general use made by W. L. and S. T. Merwin, Milford.

FORMULA.

700	pounds	Muriate of Potash,	costing	$14.91
3,400	"	Dissolved Bone Black,	"	44.20
500	"	Tankage,	"	9.00
700	"	Sulphate of Ammonia,	"	2.52
500	"	Bone,	"	8.00
2,200	"	Fish containing some potash,	"	24.20
8,000				$102.83

Materials cost $26.43 delivered at Milford.

3188. Mixture for Oats, made by T. J. Stroud, Shaker Station.

FORMULA.

800	pounds	Tankage.
700	"	Castor Pomace.
400	"	Nitrate of Soda.
200	"	Muriate of Potash.
100	"	Dissolved Bone Black.
100	"	Plaster.
2,300		

3189. Mixture for Potatoes, made by T. J. Stroud, Shaker Station.

FORMULA.

700	pounds	Tankage.
500	"	Castor Pomace.
50	"	Nitrate of Soda.
400	"	Muriate of Potash.
250	"	Double Sulphate of Potash.
100	"	Dissolved Bone Black.
100	"	Plaster.
2,100		

3191. Made by Dennis Fenn, Milford. It contains tankage, dissolved bone black, nitrate of soda and ashes. Exact proportions not known.

3205. Mixture made by H. S. Frye, Poquonock.

FORMULA.

4,000	pounds	Cotton Seed Meal,	costing	.....	$49.00
1,200	"	Dissolved Bone Black,	"	.....	15.60
900	"	Double Sulphate of Potash,	"	.....	13.50
300	"	Sulphate of Ammonia,	"	.....	10.80
1,600	"	Tankage,	"	.....	28.80
8,000					$117.70

Materials cost $29.42 per ton delivered at Windsor.

3207. Mixture for Tobacco, made by A. E. Holcomb, Poquonock.

FORMULA.

150	pounds	Sulphate of Ammonia,	costing	.....	$ 5.40
800	"	Tankage,	"	.....	14.40
600	"	Dissolved Bone Black,	"	.....	7.80
450	"	Double Sulphate of Potash,	"	.....	6.75
2,000					$34.35

Materials cost $36.15 per ton delivered at Poquonock.

3226. Mixture for Corn, made by Dennis Fenn, Milford.

FORMULA.

500 pounds	Bone,	costing		$ 8.00
200 "	Muriate of Potash,	"		4.26
600 "	Dissolved Bone Black,	"		7.80
500 "	Tankage,	"		9.00
200 "	Nitrate of Soda,	"		5.00
2,000				$34.06

Materials cost $35.06 per ton delivered at Milford.

3267 and **3268.** Mixtures made by J. M. Brown, Poquonock, formulas not given.

3273. Mixture for Corn, made by T. J. Stroud, Shaker Station.

FORMULA.

800	pounds	Castor Pomace.
900	"	Tankage.
200	"	Muriate of Potash.
100	"	Dissolved Bone Black.
100	"	Nitrate of Soda.
100	"	Plaster.
2,200		

3281. Mixture made by E. J. Wells, East Windsor Hill.

FORMULA.

150	pounds	Sulphate of Ammonia.
700	"	Dissolved Bone Black.
700	"	Tankage.
245	"	High Grade Sulphate of Potash.
1,795		

Materials cost $34.50 delivered at East Windsor Hill.

3282. Mixture made by E. J. Wells, East Windsor Hill.

FORMULA.

262	pounds	Muriate of Potash.
800	"	Dissolved Bone Black.
700	"	Tankage.
266	"	Nitrate of Soda.
2,028		

Materials cost $31.50 per ton delivered at East Windsor Hill.

3283 and **3284.** Mixtures for general use made by H. G. Osborne, East Windsor Hill.

Home Mixed Fertilizers.—Analyses and Valuations.

Station No.	Name.	Nitrogen.					Phosphoric Acid.					Potash.		Chlorine.	Valuation per Ton.	Cost of Raw Material per Ton, Delivered.
		As Nitrates.	As Ammonia.	Organic.	Total Found.	Total Calculated.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Calculated.	Found.	Calculated.			
3125	S. E. Curtiss, Home Mixture	1.75	....	1.85	3.60	*3.9*	6.40	2.32	1.32	10.04	*10.9*	5.84	*5.7*	3.79	$30.48	$34.09
3153	N. D. Platt, Mixture for General Use	....	1.64	2.32	3.96	*3.9*	7.02	3.16	2.34	12.52	*13.9*	6.35	*6.3*	4.05	36.06	36.37
3154	G. F. Platt, Mixture for Potatoes	.74	.60	3.22	4.56	*4.3*	5.39	4.61	5.11	15.11	*17.3*	2 08	*1.9*	.41	34.11	35.07
3155	R. M. Treat, Mixture for Potatoes	....	1.60	1.63	3.23	*3.0*	10.25	1.53	.56	12.34	*12 5*	6.53	*8.4*	6.14	35.77	35.68
3156	Dennis Fenn, Mixture for Potatoes	1.71	....	3.06	4.77	*4.5*	5.79	3.29	2.68	11.76	*13.9*	5.79	*5.9*	5.46	34.91	36.43
3160	W. L. & S. T. Merwin, Home Mixture	....	1.97	1.61	3.58	*3.6*	7.95	1.77	.55	10.27	*10.7*	5.42	*5.1*	5.19	32.76	26.43
3188	T. J. Stroud, Mixture for Oats	2.95	....	3.56	6.51	*6.2*	.86	3.84	2.04	6.74	*7 9*	6.08	*4.7*	....	33.02	....
3189	T. J. Stroud, Mixture for Potatoes	.32	....	3 00	3 32	*3.4*	.83	3.49	1.77	6.09	*7.6*	15.85	*13 1*	9.70	32.38	....
3191	Dennis Fenn, Mixture for Potatoes	.94	....	2 36	3.30	....	1.31	3.51	5.07	9.89	....	6.36	....	.54	26.30	....
3205	H. S. Frye, Home Mixture	....	.74	4.85	5.59	*5.4*	2.40	3.01	2.13	7.54	*7.8*	6.82	*4 0*	2.37	33.84	29.42
3207	A. E. Holcomb, Home Mixture	....	1.06	2.20	3.26	*3.6*	5.81	4 17	2.75	12.73	*13.2*	5.90	*5.6*	....	33.89	36.15
3226	Dennis Fenn, Home Mixture	1.45	....	2.78	4.23	*3.9*	5.60	4.72	4.14	14.46	*15.8*	5.32	*5.2*	4.23	35.32	35.06
3267	J. M. Brown, Home Mixture	....	2.69	2.32	5.01	....	5.66	6.34	2.47	14.47	....	3.10	....	.32	40.03	35.00
3268	J. M. Brown, Home Mixture	....	.34	1.92	2.26	....	4.34	5.53	2.22	12.09	....	17 22	....	.68	42.10	35.00
3278	T. J. Stroud, Mixture for Corn	.97	....	4.35	5.32	*4.9*	.16	5.32	1.88	7.36	*9.2*	5.54	*5.0*	5.21	30.28	....
3281	E. J. Wells, Home Mixture	....	1.55	2.41	3.96	*3.9*	4.16	6.33	4.03	14.52	*13.5*	6.76	*6.8*	.54	38.27	34.50
3282	E. J. Wells, Home Mixture	1.63	....	2.14	3.77	*4.1*	3.57	6.12	4.21	13.90	*12.7*	7.67	*6.7*	6.79	34.84	31.50
3283	H. G. Osborne, Home Mixture	....	1.20	1.71	2.91	....	5.02	3.83	1.92	10.77	....	11.01	....	.93	36.15	....
3284	H. G. Osborne, Home Mixture	.99	....	2.28	3.27	....	6.83	3.38	.69	10.90	....	8.70	....	5.19	34.41	....

Miscellaneous Fertilizers and Manures.

Cotton-Hull Ashes.

The analyses of 33 samples of this material are tabulated on page 82.

Samples numbered **3098** and **3104** represent the same stock. The analysis of the first sample being unsatisfactory, showing less potash than was guaranteed, and the amount of ashes represented being very considerable, a second sample, No. **3104**, was drawn by a Station agent which showed a much higher per cent. of potash than the first sample.

By reference to the last column of the tables it is seen that actual potash in these samples has cost from 3.2 cents to 8.9 cents per pound.

The ashes selling for $40.00 per ton, we are informed, are screened ashes, free from the large lumps which the cheaper ashes contain. The analyses show that these ashes selling at the higher price have contained on the average more potash than the "cheaper" ashes and the potash in them has cost less per pound; 4.3 cents on the average as against 4.7 cents.

The highest per cent. of water-soluble potash found in any of these samples is 35.23, the lowest 15.50 and the average percentage 25.41.

Canada Unleached Wood Ashes.

All the analyses of Canada ashes made during the year are tabulated on page 86. The first two analyses, Nos. **3361** and **3379**, were made on samples drawn by a Station agent experienced in the work. The other samples were drawn by dealers or consumers. As the following data show, some of them certainly did not at all represent the goods whose value they were intended to fix, but the analyses are published to emphasize the need of great care in drawing and bottling the samples and of sending us full particulars regarding them.

No. **3361**, sampled by a Station agent, was guaranteed to contain 5½ per cent. potash and 1½ per cent. phosphoric acid. When the dealer was informed of the result of the analysis he promptly remitted to the purchaser a sum sufficient to fully cover the discrepancy between the guaranteed and actual composition. Subsequent investigation by the dealer convinced him that the poor

Analyses of Cotton Hull Ashes.

Station No.	Dealer or Purchaser.	Sampled by	Soluble Phosphoric Acid.	"Reverted" Phosphoric Acid.	Insoluble Phosphoric Acid.	Potash Soluble in Water.	Cost per ton.	Valuation per ton.	Potash cost per pound in cents.
3097	H. K. Brainard, Thompsonville.	Arthur Sikes, Suffield.	2.45	5.83	1.35	24.70	$33.00	$40.38*	4.0
3098	R. E. Pinney, Suffield.	W. H. Prout, Suffield.	.16	6.81	.19	28.57	40.00	41.98*	5.1
3099	W. W. Cooper, Suffield.	O. C. Rose, W. Suffield.	.64	6 34	1.23	22.30	35.00	35.55*	5.4
3102	J. E. Soper & Co., Boston, Mass.	A. E. Holcomb, Poquonock.	1.60	5.50	2.20	17.44	30.00	30.87*	5.2
3104	R. E. Pinney, Suffield.	Station Agent.	.18	7.49	.22	35.23	40.00	48.15*	4.2
3109	From Texas Oil Mills.	S. L. Smith, Poquonock.	.46	4.36	1.36	21.42	28.00	31 38*	4.7
3111	I. L. Spencer, Suffield.	J. A. Hemenway, Suffield.	.64	7.38	3.26	23.00	32.00	38.69*	4.0
3114	I. L. Spencer, Suffield.	Robert Obram, Thompsonville.	.67	7.47	2.17	22.70	32.00	38.11*	4.1
3121	National Oil Co., Galveston, Texas.	Alfred Spencer, Suffield.	1.02	6.73	1.21	24.64	28.00	39.31	3.2
3123	Unknown.	B. F. Case, Canton Center.	.83	5.48	2.03	21.15	34.00	33.63	5.5
3144	Edward Austin, Suffield.	Frederick Clark, Suffield.	.83	5.93	1.30	26.98	33.00	40.43	4.1
3151	R. A. Parker, Warehouse Point.	Station Agent.	1.92	7.49	.75	31.26	40.00	48.99	4.0
3152	Olds & Whipple, Hartford.	A. H. Clark, Poquonock.	2.94	7.21	.71	30.98	40.00	49.86	3.9
3157	R. E. Pinney, Suffield.	C. H. Wells, Suffield.	1.97	9.44	.94	28.42	40.00	48.95	3.9
3158	Olds & Whipple, Hartford.	L. L. Bedortha, Windsor.	.58	7.35	.35	29.72	40.00	44.78	4.7
3159	Olds & Whipple, Hartford.	L. L. Bedortha, Windsor.	2.37	9.21	1.60	29.00	40.00	50.14	3.7
3161	Olds & Whipple, Hartford.	A. A. Viets, Bloomfield.	1.12	8.40	3.82	16.66	35.00	34.24	5.8
3165	R. E. Pinney, Suffield.	C. H. Wells, Suffield.	1.71	8.71	.52	30.22	40.00	49.26	3.9
3166	R. E. Pinney, Suffield.	C. H. Wells, Suffield.	1.73	8.88	.84	28.82	40.00	48.13	4.1
3168	James Van Gelder, W. Suffield.	F. C. Root, Suffield.	.69	7.26	1.52	22.55	....	37.40	..
3201	R. E. Pinney, Suffield.	D. L. Brockett, Suffield.	2.91	7.01	2.72	27.34	....	46.33	..
3203	F. W. Muck, Agent.	H. S. Frye, Poquonock.	1.92	5.64	1.11	8.56	....	21.39	..
3204	F. W. Muck, Agent.	H. S. Frye, Poquonock.	.06	6.12	.57	29.10	....	41.50	..
3210	R. E. Pinney, Suffield.	H. H. Austin, Suffield.	1.47	7.46	.64	30.40	40.00	47.24	4.3
3211	R. E. Pinney, Suffield.	H. H. Austin, Suffield.	1.82	8.93	1.06	27.17	40.00	46.62	4.2
3225	T. Soule & Co., New Milford.	E. A. Wildman, New Milford.	1.04	6.23	2.26	25.12	35.00	39.53	4.6
3249	Edwin Copley, W. Suffield. bought of W. F. Fletcher, Southwick, Mass.	F. C. Root, Suffield.	.38	6.89	2.04	18.99	35.00	32.65	6.1
3250	H. N. Loomis, W. Suffield.	F. C. Root, Suffield.	2.45	7.05	2.10	27.58	40.00	45.68	4.5
3252	F. W. Rising, W. Suffield.	F. C. Root, Suffield.	1.79	8.11	2.38	26.18	40.00	44.78	4 6
3270	F. W. Culver, W. Suffield.	F. C. Root, Suffield.	1.07	8.65	2.15	24.72	40.00	42.74	4 9
3294	H. M. Rose, W. Suffield.	F. C. Root, Suffield.	2.00	8.25	2.75	25.98	40.00	45.26	4.5
3295	C. L. Austin, W. Suffield.	F. C. Root, Suffield.	2.30	7.03	2.38	26.48	40.00	44.31	4.7
3364	H. K. Brainard, Thompsonville, from American Oil Co.	R. C. Gaines, Thompsonville.	trace.	8.30	1.13	15.50	33.00	22.45	8.9

* These figures based on the schedule of valuation for 1891, differ from those originally reported before the new schedule was adopted.
† Allowing 3, 7½ and 4 cents per pound respectively for soluble, reverted and insoluble phosphoric acid as in superphosphates.

quality of the ashes was due to their being put in hired storage, before shipment, which storage did not fully protect them from wetting.

The two samples, **3362** and **3378**, are instructive, as it is alleged that both were taken from the same lot. No. **3362** was sent with a letter from which it was fairly inferred that a number of purchasers had joined in a purchase and in drawing and sending the sample. After the analysis was reported and inquiry made the purchaser wrote, "It was drawn by the dealer and some other gentlemen who assured me that it was a fair sample of the cargo [boat load]. I did not see the drawing. I have ten tons of the same ashes and will very carefully take a sample."

Regarding the second sample, **3378**, he writes, "I send you a carefully drawn sample of those ashes. I got it by digging three holes in different sides of the pile not too near the bottom and taking out of each and mixing thoroughly together." The second sample was taken sometime after the first one. In the meantime the ashes had lain in a pile on the ground but the purchaser thinks had not been rained on.

It will be seen that the first sample drawn by the dealer contained 11.14 per cent. of water-soluble potash. The second sample, drawn by the purchaser, contained 5.01 per cent. of potash, less than half as much.

The purchaser of the sample **3360**, wrote when sending it, "The car load was purchased by me from Canada, price $12.00 per ton delivered here. I think them very fine if they show up as well as they look." Later, after the analysis was made, he wrote replying to inquiry: "I had ordered a car of ashes from Canada and requested the dealer to send me a sample of them by mail when loaded. I used what I wished to" (of the sample) "then sent them to you. On receiving your report I wrote to the seller who states that he was not there when the car was loaded and he thinks *his man sent me that sample from another lot* of ashes made entirely from elm wood!"

It should not need to be said that a sample drawn at random by the hired man of a dealer in Canada has little worth in fixing the value of a car load of ashes delivered here in Connecticut.

When the car load arrived the purchaser drew a sample himself and sent it to the Station properly authenticated. This is No. **3368** in the table. The sample drawn in Canada by the dealer's "man" showed 14.49 per cent. of potash, the one drawn

from the goods delivered showed 4.10 per cent.—less than one-third as much.

Samples **3367** and **3384**, representing a lot originally consisting of 15½ tons, were sent from Darien, Ct. The analysis of **3367** was so unsatisfactory to the seller living in Ontario, Canada—he having guaranteed 5 per cent. or over of potash—that he desired another analysis from a fresh sample. This is stated to have been drawn from the remaining ashes in the manner requested by him, from the center of the parcel. A noticeable difference between the two samples is the 8.4 per cent. less moisture contained in the latter. **3367** was sent to the Station, Sept. 10th, and **3384** Oct. 16th. Both were sent in small paper boxes and loss or gain of moisture may have easily occurred.

When the analyses are recalculated, after deducting the variable moisture, we have in the *dry ashes* the following percentages:

	3367.	3384.
Potash, soluble in water	3.54	4.03
Phosphoric acid	1.18	1.55
Carbonate of lime	73.98	77.66
Sand and silica	9.06	10.34

A more complete analysis of **3384** serves to show the amounts of the other ingredients in these ashes.

Potash, soluble in water	4.00
Soda, " "	.50
Lime, soluble in hydrochloric acid	42.74
Magnesia " " "	4.03
Sulphuric acid, soluble in hydrochloric acid	.82
Phosphoric acid, " " "	1.53
Carbonic acid	24.49
Sand and silica, insoluble in acid	10.17
Charcoal	2.09
Moisture	1.73
Alumina, oxides of iron, and manganese, and undetermined matters of no fertilizing value	7.90
	100.00

In view of the experience of the past season, the Station declines to analyze, at public expense, any samples of wood or cotton hull ashes which are not drawn in accordance with its directions and *fully* described on a blank form which will be sent to any one in the State on application.

Substitutes for Unleached Ashes.

Very considerable quantities of ashes are annually brought into the State from Canada. There is no way of learning the total quantity, but we are informed that in Westport, Southport and near-lying towns alone about 800 tons have been sold the last season. In view of the fact that the quality of the "Canada ashes" sold in Connecticut has deteriorated of late it is worth considering whether a substitute as serviceable and considerably cheaper may not be found. A ton of unleached Canada ashes of good quality contains:

Sand, earth and coal	260	pounds.
Water	240	"
Oxide of iron, alumina, carbonate of soda, etc.	131	"
Actual potash	110	"
Phosphoric acid	39	"
Carbonate with some hydrate of lime and magnesia	1220	"
	2000	

The agricultural value of ashes consists largely in the finely divided carbonate of lime which they contain, which is of great account in many cases as an amendment and in promoting the processes of decay and nitrification within the soil.

It is safe to say that the carbonates and phosphates of potash, magnesia and lime constitute the entire agricultural value of ashes. Can we then provide 110 pounds of potash, 39 of phosphoric acid and 1220 of carbonate of lime in fine condition in some other form cheaper than ashes?

An application in the late fall of 20 bushels of burned oyster shell lime (40 pounds to the bushel), at 12 cents per bushel would supply as much lime as a ton of ashes at a cost $2.40, 500 pounds of cotton hull ashes in addition would cost $8.75 and supply as much or more potash than a ton of Canada ashes and very considerably more phosphoric acid. The weight of these two things would be 1300 pounds as against 2000 pounds of Canada ashes which involves a saving in cartage—the cost $11.15, a little less than Canada ashes cost on the average.

The comparison is here made with ashes of excellent quality. With ashes of lower grade which are more common in our markets to-day, the showing for the substitute would be much more favorable.

Or if cotton hull ashes are not available, for them may be used 220 pounds of high grade sulphate of potash and 150 pounds of

Analyses of Unleached Canada Ashes.

	3361	3362	3378	3360	3368	3385	3396	3397	3380	3395	3379	3367	3384
Potash, soluble in water	2.92	11.14	5.01	14 49	4.10	3.93	4.74	4.42	7.17	8.75	4.65	3.19	4.00
Phosphoric acid	1.28	1.27	1.50	1.13	1.44	1.22	1.42	1.34	1.34	.96	1.48	1.06	1.53
Carbonate of lime*	56.40	....	50.60	63.20	57.50	46.90	53.60	45.80	56.10	59.60	57.20	66.50	76.32
Sand and silica	13.97	6.39	12.83	6.08	10.80	24.20	20.24	27.08	14.75	19.33	10.65	8.15	10.17
Water, expelled at 212°	15.92	....	17.80	9.00	16.00	11.40	4.45	7.35	6.42	3.45	15.05	10.12	1.73
Cost per ton	$12.00	10.00	10.00	12.00	12.00	10.50	12.00	10.50	12.00	15.00			

* Equivalent to the total calcium oxide (CaO) found soluble in hydrochloric acid.

some cheap steamed bone like Peter Cooper's Bone, and 800 pounds of oyster shell lime, the three costing $11.10.

The above named mixtures would be close imitations of superior wood ashes not only as respects the kinds and proportions of fertilizing elements, but also as to the forms or combinations of those elements. Still cheaper and in most cases probably no less effective, would be a mixture of 800 pounds (20 bushels) of burned oyster shell lime with 150 pounds of Peter Cooper's Bone and 220 pounds of muriate of potash—the total weighing 1170 pounds and costing $9.45.

The oyster shell lime being caustic should be put on in the late fall or early spring and being fine and pulverulent it will soon be converted into carbonate.

Stone lime could be used instead of oyster shell lime but being in hard lumps would require slacking before being sown. The sulphate or muriate of potash and bone are best applied in spring.

It is hoped that our farmers may make thorough trial of these substitutes which are considerably cheaper than the average of Canada ashes, quality as well as price being taken account of.

ASHES FROM HOUSEHOLD FIRES IN CONNECTICUT AND FROM FACTORIES.

3399. Sample of ashes gathered from house to house in Torrington.

3400. Sample of ashes gathered from a single house. Both of the above sent by H. Von Tobel, Harwinton.

3402. Ashes from The Coe Co. Brass Works, Torrington. Sampled and sent by the Echo Farm Co.

ANALYSES.

	3399	3400	3402
Potash	5.53	4.11	2.83
Phosphoric acid	3.18	4.00	2.18
Cost per bushel	18 cents.		12 cents.

LIME KILN ASHES.

3398. Sent by D. C. Spencer, Saybrook.

3403 and **3404** sent by S. A. Eddy, Canaan, from the Canaan Lime Co.; **3403** was from a pile which had been exposed to the weather for some time; **3404** was from a pile on which fresh ashes were being dumped.

ANALYSES.

	3398	3403	3404
Potash	.33	.44	.41
Phosphoric acid	.10	....	....
Lime	62.05	26.87	30.66
Insoluble in acid	....	2.41	1.54
Moisture	....	29.54	18.16

These "ashes" contain about a tenth of one per cent. of phosphoric acid and less than a half of one per cent. of potash. They will be useful as a cheap form of lime for "liming" land where that is desirable.

RAG DUST.

3374. A sample of the dust from Egyptian rags, which is one of the wastes from the Windsor Locks paper mill, was sent to the Station by R. E. Pinney, Suffield. It contains .96 per cent. of ammonia and only traces of phosphoric acid, but is said to have greatly increased the crops on land to which it was applied very liberally. Its action on the soil must be largely mechanical.

HEN MANURE.

3145. A sample of "fresh hen manure" from stock of E. M. Spalding, Suffield. Sampled by J. S. Gardner, Suffield.

ANALYSIS.

Moisture	34.87
Organic and volatile matter	20.28
Ash	44.85
	100.00
The organic matter contains: Nitrogen	.56
The ash contains: Sand and earth	9.41
Phosphoric acid	.35
Potash	.36

BEEF SCRAP.

3146. Sampled and sent by E. N. Spalding, Suffield. This consisted of lumps of dried meat and raw bones. It contained 7.44 per cent. of nitrogen and 5.14 per cent. of phosphoric acid. It also contained 11.07 per cent. of moisture and 23.14 per cent. of grease.

The material could probably be best used in the compost heap. At the price charged, $1.75 per hundred or $35.00 per ton, it would be poor economy to buy it for a fertilizer.

Muck.

3223. A sample sent by G. H. Bartlett of North Guilford, who writes regarding it: "The sample is from a swamp of twenty-five acres. Bottom is a very hard gravel—looks like drift. Thickness of muck 5 to 10 feet. This sample came from where it was five feet deep. The first two feet were rejected because contaminated with leaves, sticks, etc. The sample therefore represents the layer between the second and fifth foot."

Analysis.

	As received.	Water-free.
Water	87.22	----
Organic and volatile matters	11.66	91.23
Ash	1.12	8.77
	100.00	100.00
Nitrogen	.31	2.45
Phosphoric acid	.017	.13

Over nine-tenths of this material is vegetable matter. It has much less sand and earth mixed with it than most of the samples which we have examined.

The nitrogen of muck or peat is usually in a very inert condition, but as an amendment peat is very valuable on some soils.

REVIEW OF THE FERTILIZER MARKET.

For the Twelve Months ending December 31, 1891.

Nitrogen.

Nitric Nitrogen.

The *wholesale* quotation of nitrogen in nitrates has fluctuated greatly during the last year on account of the political disturbances in Chili. The agreement of the producers to limit the output of nitrate of soda, so as to maintain prices was suspended by the seizure of the mines by the Congressional party who sold all the nitrate possible to obtain means for carrying on the war with Balmaceda. The Balmaceda government however, began proceedings to exact an export duty in this country, on nitrate which had already paid a duty to the Congressional party. Finally when the Balmaceda party collapsed, the original agreement as to limiting the output is stated to have been put in force again.

The nitrogen of nitrate of soda cost in New York at *wholesale* in January, 1891, 10.9 cents per pound. It rose rapidly till April when it cost 14.4 cents, fell again to 11.3 cents in August and then rose to 13.6 in October, and was quoted at 13.3 in December.

The average wholesale cost for the year 1890 was 11.5 cents per pound; for the year 1891, 12.9 cents per pound.

The *retail* price of nitrogen in nitrate of soda in this State during the last season has been about 15.7 cents per pound. See page 27.

Ammonic Nitrogen.

The *wholesale* price of nitrogen in sulphate of ammonia has fallen somewhat during the year. It was 16.5 cents per pound in January, 1891, began falling in May to 16 cents, in October to 14.7 cents, at which price it was quoted till the end of the year.

The average wholesale price of nitrogen in this form in 1890 was 16 cents per pound, in 1891, 15.6 cents.

The *retail* price of nitrogen in sulphate of ammonia in this State during the last season was about 17½ cents per pound. See page 28.

Organic Nitrogen.

The wholesale price of nitrogen in Dried Blood has been somewhat higher in 1891 than 1890. It has fluctuated between 11.0 cents per pound in January and 12.6 cents in November, while the average price for the year for nitrogen in red blood has been 12.3 cents per pound; for nitrogen in black blood 11.7 cents. In 1890 these average prices were 11.8 cents per pound in red blood and 11.3 cents in black blood.

Nitrogen in Azotin has been quoted through the year at 11.5 cents per pound at *wholesale*, this being somewhat lower than the average for the previous year.

Dried Fish Scrap which is considerably used in mixed fertilizers has risen in price during the year from $19.25 per ton in January to $19.75 in April, $20 in June, $21 in July, $21.35 in August, $21.75 in September, and $23.75 in December.

Acidulated Fish has also risen from $9.50 per ton in January, 1891, to $13.25 in November and December.

As has been shown by the analyses and quotations given on previous pages, Organic Nitrogen has *retailed* this year in Connecticut at the following prices:

In Castor Pomace..... 13.9 to 15.7 cents per pound—see page 29.
In Cotton Seed Meal.. 13.4 to 15.3 cents per pound—see page 29.

Dried Blood is not sold in any quantity in the State at retail, organic nitrogen being purchased either in cotton seed meal, castor pomace, bone or tankage.

PHOSPHATIC MATERIALS.

Refuse Bone Black has remained steady through the year at $18.50 per ton.

Rough Bone and Ground Bone have been steady at $21.50 and $26.50 respectively.

Bone Meal, quoted at $22.75 in April has risen to $23.25.

Ground Charleston Rock, quoted at $9.75 till June has been quoted since then at $9.25 per ton.

Acid Phosphate, 14 per cent. available, has been quoted throughout the year at 73¾c. per unit which is equivalent to 3.7 cents per pound for available phosphoric acid.

The *retail* price of available phosphoric acid in dissolved bone black, which is the only form of plain superphosphate in our market at present has been about 8 cents per pound in Connecticut. See page 31.

POTASH.

Muriate of Potash.

The *wholesale* price of actual potash in this form has advanced during the year from 3.58 to 3.68 cents per pound.

Actual potash in this form has been sold at *retail* in Connecticut the past year for 4.2 cents per pound. See page 32.

Double Sulphate of Potash and Magnesia.

The *wholesale* quotation has remained constant through the year at 4.53 cents per pound for actual potash till December, when it was quoted at 4.63 cents.

Potash in this form has cost at *retail* in Connecticut from 5.6 to 5.9 cents per pound. See page 32.

High Grade Sulphate of Potash.

This material contains about the same per cent. of potash as the muriate but is entirely free from chlorides.

The *wholesale* quotations have made actual potash cost 4.33 cents per pound during the whole year till December when it rose to 4.41 cents.

It has not, to our knowledge, been retailed in Connecticut this year.

Kainit.

Kainit has sold at *wholesale* from $8.75 to $10.00 per ton during the year, the average price being $9.25, at which price the actual potash of kainit would cost about 3.8 cents per pound *wholesale.*

The market quotations given above are taken from the "Oil Paint and Drug Reporter," published in New York. The weekly quotations for each month are averaged, and this average is taken as the quotation for the month.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review:

Phosphate rock, kainit, bone, fish-scrap, tankage, and some other articles are quoted and sold by the ton. The seller usually has an analysis of his stock and purchasers often control this by an analysis at the time of purchase.

Sulphate of ammonia, nitrate of soda and muriate of potash are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

Blood, azotin and ammonite are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the percentage of ammonia by 14 and divide that product by 17). A "unit of ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain 8½ units of ammonia, and if quoted at $2.25 per unit, a ton of it will cost 8½×2.25= $19.13.

The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given:

Ammonia at $3.00	per	unit	is equivalent to	nitrogen at	18.2	cts. per lb.
" 2.90	"	"	"	"	17.6	"
" 2.80	"	"	"	"	17.0	"
" 2.70	"	"	"	"	16.4	"
" 2.60	"	"	"	"	15.8	"
" 2.50	"	"	"	"	15.2	"
" 2.40	"	"	"	"	14.6	"
" 2.30	"	"	"	"	14.0	"
" 2.20	"	"	"	"	13.4	"
" 2.10	"	"	"	"	12.8	"
" 2.00	"	"	"	"	12.2	"
" 1.90	"	"	"	"	11.6	"
" 1.80	"	"	"	"	11.0	"

Commercial Sulphate of Ammonia contains on the average 20.5 per cent. of nitrogen, though it varies considerably in quality. With that per cent. of nitrogen (equivalent to 24.3 per cent. of ammonia),

At 4	cents per lb.	Nitrogen	costs	19.5	cents per lb.
" 3⅞	"	"	"	18.9	"
" 3¾	"	"	"	18.3	"
" 3⅝	"	"	"	17.6	"
" 3½	"	"	"	17.0	"
" 3⅜	"	"	"	16.4	"
" 3¼	"	"	"	15.8	"
" 3⅛	"	"	"	15.2	"
" 3	"	"	"	14.6	"
" 2⅞	"	"	"	14.0	"
" 2¾	"	"	"	13.4	"

Commercial Nitrate of Soda averages 95 per cent. of the pure salt or 16.0 per cent. of nitrogen.

If quoted at	3.0	cents per lb.	Nitrogen costs	18.8	cents per lb.
"	2.9	"	" "	18.2	"
"	2.8	"	" "	17.5	"
"	2.7	"	" "	16.9	"
"	2.6	"	" "	16.2	"
"	2.5	"	" "	15.6	"
"	2.4	"	" "	15.0	"
"	2.3	"	" "	14.4	"
"	2.2	"	" "	13.8	"
"	2.1	"	" "	13.2	"
"	2.0	"	" "	12.5	"
"	1.9	"	" "	11.9	"
"	1.8	"	" "	11.3	"
"	1.7	"	" "	10.6	"

Commercial Muriate of Potash and also High Grade, 98 per cent., Sulphate of Potash usually contains 50½ per cent. of actual potash.

If quoted at	2.60	cents per lb.	Actual Potash costs	5.15	cents per lb.
"	2.50	"	" "	4.95	"
"	2.40	"	" "	4.75	"
"	2.30	"	" "	4.55	"
"	2.25	"	" "	4.45	"
"	2.20	"	" "	4.35	"
"	2.15	"	" "	4.25	"
"	2.10	"	" "	4.15	"
"	2.05	"	" "	4.06	"
"	2.00	"	" "	3.96	"
"	1.95	"	" "	3.86	"
"	1.90	"	" "	3.76	"
"	1.85	"	" "	3.66	"
"	1.80	"	" "	3.56	"
"	1.75	"	" "	3.46	"
"	1.70	"	" "	3.36	"

The Double Sulphate of Potash and Magnesia has about 26½ per cent. of actual potash.

If quoted at	1.00	cent per lb.	Actual Potash costs	3.77	cents per lb.
"	1.05	"	" "	3.96	"
"	1.10	"	" "	4.15	"
"	1.15	"	" "	4.34	"
"	1.20	"	" "	4.53	"

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since January, 1889. The price given for each month is average of the four weekly quotations in that month. Sulphate of ammonia is assumed to contain 20.5 per cent. and nitrate of soda 15.6 per cent. nitrogen, and muriate of potash 50½ per cent. of actual potash or 80 per cent. of the pure salt.

WHOLESALE PRICES OF FERTILIZING MATERIALS.

		Cost of Nitrogen at wholesale in					Cost of Potash at wholesale in			
		Dried Blood.								
		Red. Cents per pound.	Black or low grade. Cents per pound.	Azotin or Ammonite. Cents per pound.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia. Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate of Potash. Cents per pound.	Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
1889.	January	16.5	16.1	16.6	15.1	16.6	3.66	4 63	5.00	4.30
	February	16.6	16.2	17.0	15.0	16.6	3.66	4.44	5.01	4.37
	March	16.6	16.2	17.1	15.2	16.6	3.66	4.48	4.88	4.20
	April	16.0	16.0	16.1	14.6	16.2	3.57	4.44	4.85	4.10
	May	15.2	14.9	15.2	13.8	15.7	3.64	4.49	4.65	4.06
	June	15.0	14.6	14.6	12.8	15.2	3.64	4.53	4.60	4.06
	July	14.8	14.3	14.2	12.5	15.1	3.64	4.53	4.56	4.06
	August	14.3	13.8	14.2	11.9	15.0	3.64	4.53	4.56	4 06
	September	14.0	13.7	14.2	12.1	15.0	3.64	4.44	4.66	4.06
	October	13.8	13.2	13.7	12.2	15.0	3.64	4.44	4.67	4.06
	November	13.6	12.9	13.6	12.3	15.4	3.64	4.44	4.75	4.06
	December	12.6	12.2	13.3	12.4	15.4	3.64	4.44	4.98	4.06
1890.	January	12.4	11.9	12.7	12.1	15.4	3.64	4.44	4.97	4.06
	February	12.4	11.8	12.5	12.0	15.4	3.64	4.44	4.97	4.06
	March	12.1	11.8	12.2	11.9	15.4	3.64	4.44	4.89	4.06
	April	12.0	11.7	12.2	11.2	15.4	3.64	4.42	4.77	4.06
	May	11.9	11.3	12.2	11.2	15.3	3.62	4.42	4.77	4.05
	June	11.9	11.4	12.1	11.2	15.8	3.62	4.42	4.77	4 00
	July	11.9	11.4	12.0	11.2	16.6	3.62	4.42	4.77	3.69
	August	11.6	11.0	11.5	11.0	16.6	3.62	4.42	4.77	3.69
	September	11.3	10.7	11.3	11.1	16.6	3.62	4.42	4.77	3.69
	October	11.4	10.8	11.7	11.6	16.5	3.62	4.42	4.17	3.69
	November	11.5	10.9	11.4	11.6	16.5	3.55	4.27	4.06	3.69
	December	11.5	10.9	11.4	11.6	16.5	3.62	4.53	4.31	3.69
1891.	January	11.0	10.5	11.5	10.9	16.5	3.58	4.53	4.33	3.69
	February	12.0	11.0	11.5	12.5	16.5	3.58	4.53	4.33	8 69
	March	12.5	11.9	11.5	14.3	16.5	3.68	4.53	4.33	3.69
	April	12.4	12.0	11.5	14.4	16.5	3.68	4.53	4.33	3.69
	May	12.3	11.7	11.5	13.6	16.0	3.68	4.53	4.33	3.69
	June	12.3	11.7	11.5	13.2	15.5	3.68	4.53	4.33	3.69
	July	12.2	11.6	11.5	12.2	15.4	3.68	4.53	4.33	3.69
	August	12.3	11.8	11.5	11.3	15.4	3.68	4.53	4.33	3.69
	September	12.3	12.0	11.5	12.2	14.8	3.68	4.53	4.33	3.69
	October	12.3	12.0	11.5	13.6	14.7	3.68	4.53	4.33	3.69
	November	12.6	12.3	11.5	13.5	14.7	3.68	4.53	4.23	3.69
	December	12.4	12.1	11.5	13.3	14.7	3.63	4.63	4.41	3.69

OBSERVATIONS ON A HERD OF MILK COWS.

The work below described is not a rigidly conducted experiment, but rather a somewhat careful observation carried on for about five months, of the rations fed, milk produced, difference in the yield of individual cows, etc., in a herd kept on a large and well-managed farm near New Haven. The object was to gather data of general interest to milk producers, which might also suggest future experiments or methods of producing milk at less cost. All the observations, determinations of fat and calculations here cited are made without the help of laboratory appliances and can be made as well by any practical feeder who has the publications of the Station at command.

At the farm referred to is a herd of about sixty milk cows. The milk produced is sold in New Haven, partly at wholesale to hotels and restaurants, partly at retail to families on two milk routes.

The herd is wholly of "natives." There were at the time no cows in the herd which even approached pure breed as far as could be learned.

It has been the practice to buy in cows from any source as needed, and turn them off to the butcher when they were judged to be unprofitable milkers.

This herd was well housed. The temperature of the stables during the winter never went below 37° and only on one day below 40°. On one day it rose to 64°, but except on that one day never rose over 58°.

The cows had fresh running water always before them in their stalls, having an average temperature of about 33°.

They were turned out to exercise for half an hour daily, except in stormy weather.

The following observations were made on the cows standing in one section of the stable, nineteen in number, and representing, as far as could be judged, the average of the herd.

It was not possible to learn how long each cow had been in milk or the average time of the herd since calving. A record is kept of the date when each cow is due to calve, but the record of dates of last calving was not in such shape that it could be fully

depended on, and some of the cows were not with calf till some months after the time of last calving.

An extreme instance is No. 9, which was served every month, from September to March, and so went without calf for six months.

About half the herd was due the following September and one-third of the herd in August.

Judging from all the data at hand, it is likely that the herd on the average was about two or three months in milk at the beginning and six or seven months in milk at the end of the test. No cow calved or dried off during the time of the observation.

The time of milking was very regularly kept at five o'clock, both morning and afternoon, and the cows were milked daily in nearly the same order, so the milkings of each cow were at very regular intervals of twelve hours.

The milk of each of the nineteen cows was accurately weighed by Mr. A. W. Ogden, chemist of this Station, morning and evening and a sample taken, in which the butter fat was regularly determined and the other ingredients in some cases.

This was done from late in November till early in April, with such omissions as pressure of other work and accidents made unavoidable. The weights were recorded on 92 days out of 133.

A record was also kept of the kind and quantity of feed used through the winter.

From the records of these observations the following statements are compiled :

I. Average Yield per Day and Head of Milk and Fat, and Per Cent. of Fat.

By Months.

Herd of Nineteen Cows.

	Pounds of Milk.	Equivalent Quarts of Milk.	Ounces of Butter Fat.	Per cent. of Fat in the Milk.
In November.....	19 lbs. 8 oz.	9.1	13.2	4.24
December	19 " 13 "	9.2	13.4	4.22
January.....	22 " 12 "	10.6	13.9	3.80
February	21 " 15 "	10.2	13.1	3.73
March	21 " 2 "	9.8	13.7	4.08
April.....	19 " 2 "	8.9	13.0	4.23
Average of the months Dec., Jan., Feb., March.....	**21 " 6 "**	**9.95**	**13.5**	**3.95**

Observations were made on the last seven days only of November and the first nine days of April, so that these two months are excluded in the average statement.

It appears that in four months out of the six, the per cent. of butter fat was above 4.0, but in February it fell to 3.7. The cause of the somewhat sudden decrease of fat in February in connection with its rise again in March does not appear.

The average yield of fat per day and cow, 13½ ounces, if separated as perfectly as possible by the centrifugal and churned with only a usual loss of fat in the butter-milk, would give less than a pound of butter per day. But the most important feature with a herd whose milk is sold to consumers is the yield of milk.

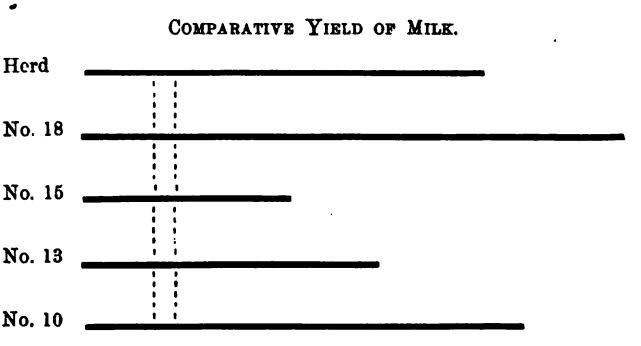
About ten quarts per day and head is the average for this herd during the time when the cows were between three months and seven months in milk.

The next table shows the average yield of the whole herd of nineteen cows for the *six* months, and in comparison the yield of some individual cows in the herd.

II. Average Yields per Day and Head of Milk and of Butter-fat from Individual Cows for Six Months.

	Whole Herd.	No. 18. Giving the most milk.	No. 15. Giving the least milk.	Two Cows about equally old in milk. No. 18.	No. 10.
Quarts of Milk	9.6	13.1	4.8	7.0	10.4
Ounces of Fat	13.4	19.4	10.0	10.9	14.8
Per cent. of Fat	4.05	4.35	6.03	4.54	4.13

The comparative yields of milk are represented by the lengths of the lines below.



The herd as has been said, was about two months in milk at the beginning of the test.

No. 18, the best milker, slipped her calf at seven months just as the test began and was in full milk during the whole of the test. She gave per day three and a half quarts more milk than the average of the herd, and three-eighths of a pound more of butter-fat; her milk contained three-tenths per cent. more of fat than that of the herd.

No. 15 was due to calve early in July and did not calve later than August, 1890. She was probably older in milk than the most of the herd. She gave only half as much milk as the average cow in the herd, four and four-fifths quarts per day, nearly three and a half ounces less of fat, but the per cent. of fat was very high, 6.08. Of course a comparison between two cows, one of which is near the beginning of lactation and the other near the end, is unfair, though so great a difference as there is between the yield of No. 18 and No. 15 cannot be explained in this case by the period of lactation.

The last two columns of the table show the yields of two cows which are comparable in respect to being about equally old in milk. No. 10, the larger milker of the two calved in May, 1890, two months earlier than No. 13, and both were due to calve August, 1891.

Here are two cows, costing the same for feeding and care, the better of the two is two months older in milk than the poorer and while the one gives 10.4 quarts a day for the six months, the other gives only 7 quarts, a difference of 3.4 quarts per day, or for the six months, of 615.4 quarts or more than $40 worth of milk.

Roughly figured the difference in the yield of fat would make a difference of 50 pounds of butter in the six months.

III. The Feed of the Cows.

Total quantity of feed eaten.

The ration was changed somewhat several times during the observations, partly to make it cheaper without making it less nutritious and partly because of the difficulty of getting a full supply of brewers' grains. No marked or sudden change in the yield of milk or butter-fat was noticed in consequence of these changes. During four months—121 days,—(and at the same rate

during the whole period of observation) the herd consumed *per head*:

	In 4 Months.	Per Day.
Hay	1240 pounds.	10¼ pounds.
Stover or corn-stalks	1283 "	10⅝ "
Turnips	302 "	2½ quarts.
Brewers' grains	1578 "	13 pounds.
Corn meal	21 "	0.17 "
Bran	70 "	0.57 "
Corn and cob meal	273 "	2.2 "
Sugar feed	228 "	1.9 "

The second column represents the *average* ration per day. No cow on any one day received all of the feeds named. The ration was changed several times as already said, and the second column is obtained by dividing the total quantity of food eaten by each cow in four months by the total number of days, viz: 121.

Gross Cost of the Feed.

To determine this with accuracy is impossible. The cost of production on any farm varies from year to year with the season, efficiency of farm help and superintendence, etc., and in any case many of the factors in the cost cannot be ascertained with accuracy. But the following figures have been assumed with the belief that so far as they relate to feed raised on the farm they will fully cover actual cost of production, and are too high rather than low. In calculating the cost of producing milk, of course the feed raised at home should be put into the account, not at its selling price, but at cost of production.

Hay is valued at $10.00 per ton, corn-stalks at $3.00, turnips at 15 cents per bushel, corn-meal at $19.00 per ton, corn and cob meal at $17.00.

Of the boughten feed bran cost $25.00, sugar feed $23.50, and brewers' grains 10 cents per bushel of 60 pounds.

Reckoned on this basis the *gross* cost of the feed *per head* for 121 days was $18.21.

Manurial Value and Net Cost of the Feed.

The *net* cost of the feed will be found by deducting from the gross cost the manure value of the feed.

Basing calculation on the average composition of the feed used the quantities of nitrogen, phosphoric acid and potash fed to each cow during the four months will be as given in the table below.

In this time the cows gave on the average 2,586 pounds or 1,202 quarts of milk.

The quantities of nitrogen, phosphoric acid and potash contained in this milk, supposing it to be of average quality, are also given in the table. It will be seen that nearly a third of both the nitrogen and phosphoric acid of the feed may go in the milk.

The third column of the table gives the quantity of the three ingredients which are to be credited to the manure account, and the last column their valuation. In this calculation phosphoric acid and potash are valued as in commercial fertilizers at 7 and 4½ cents per pound respectively, but nitrogen is valued at only 8 cents per pound. This is done in order to be on the safe side, and in view of the losses of nitrogen from the manure pile both by its escape as nitrogen gas, and in the leaching and drainage, and also in view of the more inert condition of the nitrogen of manure as compared with that of the high grade nitrogenous fertilizers like nitrate of soda, sulphate of ammonia, dried blood, cotton-seed meal, etc.

POUNDS OF NITROGEN, PHOSPHORIC ACID AND POTASH IN THE FEED, MILK AND MANURE OF ONE COW IN FOUR MONTHS.

	In the Feed.	In the Milk.	In the Manure.	Valuation of that in the Manure.
Nitrogen	46.6	15.5	31.1	$2.49
Phosphoric acid	18.3	5.8	12.5	.88
Potash	38.8	3.3	35.5	1.60
				$4.97

Deducting this from the gross cost of the feed, $18.21 there remains $13.24, which may be called the net cost of the feed of one cow for four months, or 121 days. For a single day then, on the average, a single cow's feed costs 15.05 cents gross or 10.94 cents net.

If milk is selling at 7 cents a quart, 2.15 quarts of each cow's milk must go to pay the gross cost of her feed or 1.56 quarts to pay the net cost of it.

Applying these figures to those given on page 98 under II, it appears that on the average, 16 per cent. of the milk of the herd was needed to cover the net cost of their feed. Less than 12 per cent. of her milk paid for the feed of the best milker, while 32½ per cent., nearly one-third, of the milk of the smallest milker was needed to cover the cost of her feed.

This proportion is also shown by the dotted transverse lines in the diagram on page 98. The space to the left of the lines represents the part of the total yield of milk which was needed to cover the gross and net cost of the feed.

The Digestible Matter of the Feed.

As has been already said the ration was changed a number of times. But if the total quantity of feed of all kinds used in the four months had been evenly divided per day and head, it would have given a ration like that which follows. Assuming 875 pounds as the average weight of a cow, this digestible matter is calculated to 1000 pounds live weight in order to compare it with the "standard."

By the aid of the published tables of the average composition and digestibility of feeds it is possible to calculate, somewhat roughly, the quantity of digestible food, i. e. of actual nutriment that each cow daily received in this ration. The results of this calculation are as follows:

DIGESTIBLE MATTER IN THE RATION PER DAY AND HEAD.

	Dry Organic Matter.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
Hay, 10½ pounds contain	8.13	.37	1.78	2.61	.10
Stover, 10⅜* pounds contain	6.39	.27	1.26	2.24	.06
Turnips, 4.7 pounds contain	.41	.03	----	.28	---
Brewer's Grains, 13.0 lbs. contain	2.85	.54	.17	.96	.14
Corn Meal, .2 pounds contain	.15	.01	----	.11	.01
Bran, .6 pounds contain	.49	.07	.02	.25	.02
Corn and Cob Meal, 2.2 lbs. cont'n	1.84	.15	.09	1.30	.07
Sugar Feed, 1.9 pounds contain	1.66	.33	.06	.88	.15
	21.92	1.77	3.38	8.63	.55

	Organic Matter.	Albuminoids.	"Carbohydrates." Fiber and Nitrogen-free Extract.	Fat.
Per 1000 pounds live weight	25.04	2.02	13.72	.63
"Standard"	**24.0**	**2.5**	**12.5**	**.4**

The terms here employed scarcely need explanation to our stock feeders. A somewhat extended discussion of their meaning and use will be found on pages 89–111 of the Station Report for 1886.

* The digestible matter is reckoned on nine pounds of stalks, as it was found by trial that the cows left 1⅜ pounds uneaten, and that the uneaten portion had approximately the same composition as the rest.

It should be specially noted in this connection that the albuminoids, sometimes called "flesh-formers," are essential to the growth of all the tissues of the body, and therefore are particularly concerned in the production of milk, which is not a mere secretion, but rather a liquefied tissue; and if albuminoids are deficient in the food one of two things must happen: either the milk yield will shrink or the animal will consume other tissues, i. e. its own flesh and blood to produce it. The albuminoids also, rather than the fat or the starch of the feed, are most largely concerned in the production of the butter fat of milk.

The food-ingredients of each feed consists of two parts, the digestible portion which alone is real nutriment and the ballast or waste portion which goes directly through the animal into the dung and does not nourish the body at all. The proportion of these two parts in different feeds varies greatly.

For instance only about 56 per cent. of the albuminoids of good meadow hay is digestible, but 87 per cent. of that of linseed meal is digestible.

For these reasons in comparing feeds we need to calculate, not the total quantity of the albuminoids, but the quantity which is digestible and actually useful to the animals.

The "standard" represents about what a cow weighing one thousand pounds needs per day of the several food ingredients, to keep her body from waste and maintain a full flow of milk.

The standard itself is the result of a number of very accurately made tests, in each of which the weight of the animal was determined as well as the daily weight and composition of the feed, the excrement and the milk.

In comparing the average ration of the herd with the standard it appears that the cows have had an abundance of food, 25 pounds per day of organic matter as against 24 of the standard, but it also appears that while they have had 1.2 pounds more "carbohydrates" (starch, sugar, fiber, etc.), and one-fifth of a pound more fat than the standard requires, there has been half a pound less per day of the albuminoids, or "flesh-formers;" only four-fifths of the quantity required by the standard.

Of course the feeding standard is a general statement, represents an average and is not to be too literally taken. It is only a general guide, but the above comparison suggests the inquiry whether the ration fed was not seriously deficient in albuminoids and wasteful of the "carbohydrates."

NOTES ON THE ABOVE OBSERVATIONS.

1. *Ventilation.*—During these observations there was on certain days a sudden and large shrinkage in the quantity of milk; in one extreme case the loss amounted to over 15 quarts in a day from 19 cows. There was no irregularity in the time of milking or in the temperature of the stables, and no reason could be discovered for the shrinkage, except the fact that a brisk cold wind was followed the next day by warm still air. While this made no particular difference in the temperature of the stable it made a very noticeable difference in the quality of the air. The stable became close with a strong odor and at the same time the milk fell off greatly, but increased again when conditions changed.

While connection between milk yield and ventilation could not be proved in these cases it appeared highly probable. Pure air is as essential as warm air and where the herd is large and housed with great economy of space it is harder to secure under all conditions of weather.

2. *Yield of Milk and Fat from the Herd and from Individual Cows.*—It is believed that this herd was better fed, housed and tended than the general average of Connecticut herds of native stock, that the stock was as good as the average, and their yield of milk fully as good and probably above the average.

It was not far from ten quarts per day and head for the winter months.

No one wishes to be content with average efficiency but aims to secure the highest yield possible.

How then can the efficiency of the herd be increased?

Looking first at the cows themselves it appears that certain ones gave 3½ quarts a day more than the average, while others gave almost 5 quarts less than the average; that some were profitable cows to keep, while others were an expense all the time to their owners.

To find out which are the unprofitable ones is not a difficult matter. An observant man who is at the milking every day will know them well enough. But if the herd is large and hired men milk, the owner is not likely to know surely unless he will go to the trouble, which is small compared to the advantage gained, of making tests for at least three or four days in the month.

With a spring balance and a couple of pails whose weight has been brought to even pounds, by soldering on a piece of lead if necessary, it is only half a minute's work to pour each cow's milk

as brought by the milker into one of these pails, hook it on the scale and read and record the weight. It is much quicker and more accurate than to measure. But pounds of milk may be readily reduced to quarts by dividing by 2.15.

A few such tests made monthly will show what each cow is doing from the time of calving till she dries off, and to judge of her merits or demerits one needs to know this. If cream rather than milk is sold, the Babcock milk tester should be used in connection with the test of milk yield and can readily be used on the farm as well as in the laboratory.

Having fixed on the unprofitable cows of the herd the next step is to get rid of them and at the same time substitute something better. This is not easy.

If it be granted, as is claimed by breeders of pure stock, that thoroughbreds are more profitable for milk men than "scrubs," this knowledge is small help to a man who has from five to forty natives in his herd and very limited uninvested capital. He cannot turn off one herd to a butcher or to some less thrifty neighbor and buy a new thoroughbred herd.

If he turns off the poorest cows and buys in other natives as he can pick them up, he very soon finds, as was remarked in a recent dairy meeting, that the seller is also engaged in improving his herd and the buyer is likely to be no better off than he was before. The very best cows are never for sale; the very poorest cows are always for sale.

A third way which finds more favor among patrons of creameries than among those who sell whole milk is the raising of calves for one's own herd.

Most cattle keepers can afford to get and keep a thoroughbred bull which comes from stock with good milk records. This establishes the foundation for a good herd. His get, even from the "scrub" cows, are likely to be much better milkers than the average native cows which are "picked up" in emergencies here and there. And at any time when a few thoroughbred cows can be introduced, the improvement of the herd will go on more rapidly. The raising of calves looks more formidable where skim milk from the creamery is not available for feed, but in the long run may be the cheapest means of improving the herd and so lessening the cost of producing milk. Only good cows will make it pay to produce milk. The producer has got to raise them himself or pay to

have some one else do it for him. The former course will often be the best.

3. *Quality of the Feed.*—In 1881 the Station examined the rations fed on several good farms in this State and found in general more carbohydrates and less albuminoids in the rations than is given in the standard. The same thing appears in the ration which has been discussed and probably it is generally true of the feeding in this State.

It is quite likely that a pound or a pound and a half or even more per day and head of either linseed meal, gluten meal or cottonseed meal, with a corresponding diminution of the more starchy feed, corn meal, bran, etc., would have noticeably improved this ration and will improve the rations of other feeders in this State. In some cases it may happen that the flow of milk will not be noticeably increased, but that nevertheless the milk will be made from the feed instead of the cow's flesh and in consequence she will come out better in the spring.

An excess of albuminoids in the feed is not wholly wasted for the undigested portion enriches the manure. An excess of carbohydrates is less perfectly digested than where a proper proportion of albuminoids is present, and what goes into the manure is dead loss, having no manurial value.

THE BABCOCK METHOD OF DETERMINING FAT IN MILK.

The following statements on this subject, most of which were made in Bulletin No. 106, it seems best to record here in view of the great interest which is taken in the matter and the frequent inquiries about it.

Of the various quick methods for determining fat in milk and cream which have been proposed of late, the Babcock method has been most widely adopted and to us seems the safest, most convenient and rapid.

Description of the Method.—The principle of the method is this: to a carefully measured quantity of the milk in a flask provided with a narrow accurately graduated neck, made for the purpose, is added a definite quantity of strong oil of vitriol which dissolves all the solid matters of the milk except the fat. The flasks thus charged, are rapidly whirled in a centrifugal apparatus by which all the fat is brought to the surface of the mixture in a few minutes. Hot water is then added to raise this layer of melted fat into the graduated neck of the flask. The length of the fat layer, as read off on the graduation, gives at once the per cent. of fat. It may be of advantage to any one who gets this Tester to see it at the Station and learn some particulars of manipulation that can be better appreciated by seeing than by reading of them. Any one can, however, get perfectly satisfactory results for himself without further instruction than is given in the directions which accompany the machine.

The apparatus which has been used by the Station lately at the meeting of the Dairymen's Association and at farmers' institutes is made by Porter Blanchard's Sons, Nashua, N. H. A convenient apparatus is also made by the Vermont Farm Machine Co., Bellows Falls, Vt.

Rapidity of the Test.—This depends largely on the skill and activity of the operator. In the Station laboratory, a person skilled in handling such apparatus, but who has worked with this method only a few times has made determinations of fat in 40 samples of milk in an hour and forty-eight minutes.

This included time spent in mixing the milk in the sample bottles, measuring milk, acid and fat, labelling and cleaning all

the flasks and apparatus used, recording the results, and leaving everything in perfect order for the next use; in short *every* thing involved in any way with the operation. This is more than twice as rapid work as we were able to do at first and is made possible simply by having the apparatus conveniently arranged for the work.

Accuracy of the method.—The accuracy of this method of determining the quantity of butter-fat in whole milk has been fully tested at several stations and is settled beyond dispute.

Our own tests have given the following results. The average difference between the quantity of fat shown by this method and that shown by the standard method used in chemical laboratories, was less than one one-hundredth of one per cent. in 32 comparative tests. The greatest difference in any single case was .18 per cent. In six cases the difference exceeded .10 per cent. and in 18 cases it was .05 or less.

In 17 cases the standard method gave a lower result than the Babcock method, in 15 cases a higher result.

That is, on the average where 100 pounds of butter-fat were actually present, the Babcock test showed $99\frac{88}{100}$ pounds.

The widest discrepancy in any single case was $\frac{18}{100}$ pound or about three ounces of fat in 100 pounds.

In the majority of cases the discrepancy was $\frac{1}{2}$ of an ounce or less in 100 pounds of fat.

Accuracy of sampling indispensible.—To get a perfectly fair sample of each patron's milk is the most critical thing of all. As soon and as often as milk stands at rest, its constituents begin to separate, the cream rising to the surface. The contents of a forty quart can may be thoroughly mixed with a long handled dipper *if time and pains are taken to do it*, but it will require more time than one who has not tried it would suppose, to thoroughly mix the whole so that different samples from the same can will show the same quantity of fat when tested. The most thorough mixing is done by pouring the whole quantity of milk from one can into another.

For sampling large quantities of milk, the Vermont Station, Bulletin No. 21, recommends a sampling tube. This is simply a piece of brass tube of suitable length and an inch in diameter, having an iron wire running through it, centered by a wire loop within the tube near each end. One end of this wire is bent to form a handle, the other bears a disc of sheet iron with a rubber

packing over it. The tube is passed vertically downwards in the milk, the disc being kept away from the tube allowing it to fill as it goes down. Then the wire is drawn up, thus closing the bottom of the tube, and the tube is withdrawn, bringing with it a core or section of milk, which should represent accurately the whole quantity of milk.

This "milk thief" we have found very convenient in sampling either milk or cream.

Where the method is used by milk-gathering creameries it is very desirable to sample the milk daily, but to make the tests less frequently, perhaps once a week. To do this fairly a sample of each day's milk from each patron is put into a suitable bottle or jar, of which as many are required as there are patrons. Each jar contains an antiseptic powder which will keep the milk sweet till the end of the week when the fat in each so-called "composite sample" is determined, and the patrons are credited with the butter-fat they have supplied.

Any creamery wishing particulars of this process would do well to apply to the Iowa Experiment Station, Ames, Iowa, for Bulletins No. 9 and No. 11, and for the "Relative Value Table." The chemist of that Station, Prof. Patrick, has originated and carefully worked out the details.

The creamery of J. B. Sandford in Redding, in this State, is now paying for milk according to the butter-fat in it as shown by the Babcock test. The results are understood to be very satisfactory alike to owner and patron while the system of paying for pounds of "milk" supplied, was extremely unfair both to the proprietor and to a part of the patrons, as was shown by tests made at the creamery.

That this must be so in all cases the following considerations show.

The average per cent. of fat in 206 samples of the milk of herds carefully drawn at creameries in this State and analyzed at this Station, was 3.98, or in round numbers four per cent.

That is, if this whole quantity of milk had been mixed thoroughly together, a hundred weight of it would have contained four pounds of butter-fat.

But as was to be expected the milk from the individual dairies was of various quality. The milk of one herd contained 5.25 per cent. of fat, that of another 3.28 per cent. of fat, and while the percentage varied somewhat from day to day yet the milk of

certain herds was *uniformly* rich in fat while that of other herds was as *uniformly* poor.

These figures mean that a hundred pounds of milk, furnished by one patron, brought to the creamery five and a quarter pounds of fat, but a hundred pounds of milk from his neighbor's herd brought only three and a quarter pounds. This is an extreme case. If for illustration we assume that the milk of A's herd contains 5 per cent. of fat and that of B's herd 3.5 per cent. we have a difference between the herds which is not by any means extreme in Connecticut to-day.

A and B we will suppose produce the same quantity of milk per week, 1500 pounds, and are paid at the rate of $1.10 per hundred or about $2\frac{35}{100}$ cents per quart. (The actual price paid by different creameries is not known). Their receipts are therefore the same, $16.50 per week.

For this, A furnishes to the creamery 75 pounds ($1500 \times \frac{5}{100}$) of butter-fat and B furnishes $52\frac{1}{2}$ pounds.

That is, crediting nothing to the skimmed milk of which each patron supplied the same quantity; A, the patron who produces the richer milk, who has the better cows or who feeds more rationally, gets 22 cents a pound for butter-fat, and B the patron whose milk is the poorest, whose herd is poor or feeding injudicious, gets 31.4 cents a pound. This is a premium of 10 cents per pound of fat on thin milk, or poor stock and feeding, or on judicious watering of the milk.

It presents little inducement to better the herd or to feed for quality rather than quantity of milk.

It is obviously very unfair to all the parties concerned and bears heardest on A who has an exceptionally good herd or who feeds exceptionally well.

Now suppose this creamery changes its policy and offers as before $1.10 per hundred for "standard" milk containing four per cent. of fat but allows $2\frac{3}{4}$ cents per hundred additional for every "unit" or tenth of a per cent. of fat more than four in the milk and deducts $2\frac{3}{4}$ cents per hundred for every "unit" or tenth per cent. under four.

The two accounts will stand as follows:

Patron A. Milk contains 5 per cent. of fat.

15 hundred weight of milk, @ $1.10	$16.50
Add for 10 units per hundred, or 150 units of fat @ $2\frac{3}{4}$ cents	4.13
	$20.63

Patron B. Milk contains 3.5 per cent. of fat.

15 hundred weight of milk, @ $1.10	$16.50
Deduct for 5 units per hundred, or 75 units of fat @ 2¾ cents	2.07
	$14.43

Under this arrangement A has received $20.63 for his 1500 pounds of milk and has furnished 75 pounds of butter-fat. He has therefore received 27½ cents per pound for the butter-fat.

B has received $14.43 for 52½ pounds of butter-fat, and for each pound 27½ cents, the same that his neighbors receive for a like amount of butter-fat.

Neither A nor B can increase his receipts by watering or skimming milk nor by increasing the flow of milk at the expense of quality.

These particular prices are for nothing more than to illustrate the point. The actual rate to be paid must depend of course on what it costs the creamery to make and sell the butter.

The appearance of the Tester itself at a creamery, and of some one making tests on each patron's milk, has had in some cases a marked effect on the quality of the milk furnished thereafter.

For instance, in one case a Station chemist with the tester examined at a creamery the milk of each patron as he brought it. The milk of the previous week had made 270 pounds of butter. The following week the milk brought to the creamery fell off 590 quarts, but the butter made was 269 pounds, only a pound less than the week before.

It is believed that the practice of paying for butter-fat rather than for milk—which is rendered practicable by the methods referred to above—will gradually reduce the cost of producing butter, will increase the profits of the honest and intelligent patrons and offer more inducement than there now is for improving herds and feeding liberally for quality rather than quantity of milk.

It must be borne in mind that the Tester shows the percentage of *pure butter-fat* in the milk, not of "cream" or of butter. "Cream" varies much in composition and may contain as low as 16 per cent. of pure butter-fat or as high as 30 per cent. or even higher. Butter contains from 75 to 87 per cent. of pure butter-fat. More or less of the butter-fat of the milk however is lost in butter making, chiefly in the skimmed milk and in the butter milk.

MISCELLANEOUS NOTES ON MILK.

Solids and Fat in the Milk of Herds.

The following data on this subject have accumulated during the year. The figures refer to the milk of patrons as received at creameries.

	Feb. 19.	Feb. 20.	Mar. 7.	Mar. 12.			May 10.	Nov. 1.
No. of patrons	35	36	33	31	50	15	24	27
Solids, average per cent.	----	----	----	----	13.60	12.14	12.73	13.48
" maximum	----	----	----	----	14.93	13.38	14.44	14.93
" minimum	----	----	----	----	11.90	10.91	11.79	11.90
Fat, average per cent.	3.85	3.95	4.05	4.0	4.5	3.91	3.87	*4.52
" maximum	4.4	4.8	5.0	4.6	5.25	4.39	4.94	5.25
" minimum	3.1	3.2	3.3	3.6	3.38	3.31	3.28	3.38

Following are the results of examination of the milk of a herd of "three full blood Holsteins and nine common cows." A creamery superintendent witnessed the milking and took the sample which was drawn on March 20th:

	March 12.	March 20.
Specific gravity at 15° C.	1.030	1.032
Total solids	11.28	11.51
Fat	3.47	3.48

Effect of Sickness on the Yield and Composition of Milk.

During the observations on a herd of milk cows, described on pages 96 to 106, two cows at different times were "off their feed" for a few days. The cause and nature of the trouble, which did not appear very serious, is not known. Neither cow was in heat at the time.

The effects on the yield and composition of the milk are interesting.

Cow No. 10 for a week previous had been giving on the average 22½ pounds of milk per day, 16 ounces of butter fat, while the per cent. of fat in the morning's and night's milk ranged from 3.5 to 4.3.

On the 23rd of February it was noticed that she did not eat well. Her yield of milk and of butter fat for the next few days were as follows:

*Twelve patrons.

	Pounds of Milk.	Ounces of Fat.
Feb. 23	18½	---
" 24	15⅛	13.2
" 25	12	11.3
" 26	15	10.4
" 27	17⅛	11.4

Her daily yield was not up to what it was before her sickness till March 7.

A full analysis of her milk when she was sickest is given in the table which follows.

Cow No. 9 was seen to be off her feed on December 9.

Her record just before and during her sickness is as follows:

	Pounds of Milk.	Ounces of Fat.	Per cent. of Fat in morning's and night's Milk.
Dec. 6	21	12.6	3.9, 3.6
" 8	20½	12.3	3.9, 3.7
" 9	22⅜	14.4	4.2, 3.9
" 10	16	8.0	2.2, 3.9
" 11	7⅛	7.5	4.0, 7.0
" 12	11 15/16	12.5	6.0, 7.0
" 13	13 3/16	10.0	4.3, 4.8
" 15	15⅞	10.1	4.1, 3.9

On the 22d her yield had risen to 19 7/16 pounds, which was about her average before her sickness.

In both these cases there was a large shrinkage both of milk and of butter fat, while the per cent. of fat rose noticeably, showing that the shrinkage of fat was less than that of the milk. Analyses of this milk appear in the following table:

COMPOSITION OF MILK FROM SICK COWS.

	No. 10.				No. 9.	
	Feb. 23, night.	Feb. 24, morning.	Feb. 24, night.	Feb. 25, morning.	Dec. 11, night.	Dec. 12, morning.
Casein or curd *	3.44	2.97	3.18	3.13	2.55	2.49
Butter fat	5.77	4.83	5.24	6.49	7.02	6.02
Sugar †	4.51	4.90	4.50	4.44	4.69	4.53
Ash	.85	.72	.79	.71	.63	.66
Total solids	14.57	13.42	13.71	14.77	14.89	13.70
Water	85.43	86.58	86.29	85.23	85.11	86.30
	100.00	100.00	100.00	100.00	100.00	100.00

* Nitrogen × 6¼. † By difference.

Composition of the Milk Solids.

Casein or curd.	23.61	22.13	23.19	21.19	17.13	18.18
Butter fat.....	39.61	35.99	38.22	43.94	47.15	43.94
Sugar	30.95	36.51	32.82	30.06	31.49	33.07
Ash	5.83	5.37	5.77	4.81	4.23	4.81
	100.00	100.00	100.00	100.00	100.00	100.00

Fat in the First of the Milking and in the Strippings.

The samples **A** to **D** were drawn by Mr. W. I. Bartholomew of Putnam, and tested at a dairy institute in April, 1891. **E** is from a registered Jersey cow. The figures given are the per cents of butter fat.

	A.	B.	C.	D.	E.
First milk drawn from the udder	2.8	1.6	3.4	1.5	1.6
Last " " " "	6.1	7.5	9.8	7.2	6.2

On the Determination of Solids in Milk by Drying the Milk Alone.

The following tests, made by Mr. Winton, were to show whether the drying of milk by itself gave results practically identical with those obtained by the so-called "Sand Method."

The quantities of milk given below were heated on a water bath in a porcelain guano capsule with 10–15 grams of dry quartz sand, with frequent stirring, till most of the water was expelled and then in the drying oven at about 98° C. till the weight was constant.

For comparison, the quantities of milk given in the table below were brought into flat bottomed nickel dishes, having a diameter at the bottom of 2 inches and a height of $\frac{5}{8}$ inch. The drying was precisely as by the sand method, but without any stirring.

Weight of Milk used.	By Sand Method.	Dried in nickel dish.	The Sand Method gave more (+) or less (−).
2 grams	12.47	12.65	−.18
"	9.27	9.29	−.02
"	13.30	13.36	−.06
"	12.21	12.33	−.12
"	12.19	12.27	−.08
4.3 grams.	12.87	13.04	−.17
"	12.03	12.07	−.04
"	12.35	12.59	−.14
"	11.32	11.32	.00
"	10.91	10.88	+.03
"	13.38	13.39	−.01
3.3 grams.	11.82	11.89	−.07
"	11.36	11.49	−.13

In thirteen tests the extreme difference between the results by the two methods was .17 per cent.; the average difference was .08 per cent., and in eleven out of thirteen cases the sand method gave a lower result.

ON THE DETERMINATION OF THE FAT IN CREAM BY THE BABCOCK METHOD.

Most of the creameries in this State gather cream rather than milk and the cream is usually raised by deep setting in submerged cans at low temperatures. Inasmuch as cream raised by this method naturally varies considerably in its content of actual butter-fat and may easily be made to vary much more by fraud on the part of the creamery patron, a rapid, accurate and practicable method of determining fat in cream, for use in creameries, is particularly desirable here.

The Babcock method applied to cream has been thoroughly tested by Mr. Winton, chemist of the Station, with a view to its use by cream gathering creameries.

The same apparatus, bottles, acid and method have been employed as are recommended by Dr. Babcock with a single exception.

Mr. Winton has made and used in all the tests given below a pipette for measuring the cream which delivers 6 grams of cream quite accurately, *provided the cream was raised as above described.* The reading from the tube multiplied by three gives the per cent. of fat in the cream without further correction.

The pipette.—The pipette, made by Mr. Winton, is 6½ inches long, narrow at each end, the internal diameter at one end being about ⅛ of an inch and at the other $\frac{1}{16}$ inch.

It is designed to deliver 6 grams of cream, as the milk pipette is designed to deliver 18 grams of milk. The actual quantity delivered in several preliminary trials was 5.97–5.95–6.00 and 5.93 grams.

The number of grams of water delivered (15° C.) by this pipette in a number of trials was

	6.035
	6.038
	6.028
	6.053
	6.045
	6.035
Average	6.039

The *volume* of cream delivered will be less than that of water because a larger proportion of the cream will adhere to the sides of the pipette.

Method of using the pipette.—The cream is very thoroughly mixed by moderate agitation,—violent shaking may churn it partially or beat it full of small bubbles which are very slow to rise,—and the pipette with one end well below the surface of the cream is sucked full, a little escaping into the mouth. The upper end is closed with the tongue, and the pipette withdrawn, its tip introduced into the neck of the flask and on removing the tongue the cream flows out. *As soon as it has run out*, the adhering drop is blown out and the pipette withdrawn.

The reason for making the pipette to be completely filled with cream rather than to be filled to a mark on its stem is that it is more difficult to observe in a tube the height of cream than of milk, as the former coats the walls of the tube more thickly. By filling the tube full moreover, any bubbles on the cream surface will be removed by the mouth.

Having measured the cream into the testing flasks it is only necessary to add to each, 12 centimeters of water, from a pipette made for the purpose, and then proceed exactly as in the case of milk only multiplying the per cent. of fat, as read from the graduations, by three.

Following is a complete account of the experiments thus far made with this method, with the exception of the first ten samples examined which were quite sour when tested and had not been raised by a uniform method.

The "gravimetric method" referred to below or the laboratory analytical method, which is the standard, consisted in weighing the cream accurately on asbestus fiber in a tube, drying at the heat of boiling water till the weight was constant, and then extracting the fat completely from the tube and asbestus with absolute, alcohol-free ether, evaporating the ether, drying at the temperature of boiling water and weighing the residual fat.

Creamery No. Collected Feb. 10th, 1891.	Solids.	Fat. Babcock Method.	Fat. Gravimetric Method.	Babcock method gave more (+) or less (−) than Gravimetric Method.
3	....	21.3	21.16	+ .14
6	....	21.6	21.30	+ .30
9	....	18.9	18.64	+ .26
11	....	18.2	17.90	+ .30
19	....	20.25	20.34	+ .09
21	....	20.4	20.36	+ .04
22	....	17.7	17.76	− .06
23	....	20.25	20.17	+ 0.8
25	....	18.45	18.67	− .22
29	....	20.55	20.57	− .02
30	....	22.5	22.90	− .40

Collected Feb. 20, 1891.

2	27.40	20.4	20.16	+ .24
3	30.14	22.7	22.51	+ .19
4	25.69	18.6	18.49	+ .11
5	27.87	21.0	20.80	+ .20
6	27.40	21.9	22.09	— .19
7	27.52	19.8	19.66	+ .14
8	25.50	18.0	17.72	+ .28
9	28.36	21.0	21.02	— .02
11	31.18	23.9	23.54	+ .36
12	27.77	20.5	20.64	— .14
13	26.15	19.0	18.96	+ .04
14	28.70	21.9	21.94	— .04
15	26.38	19.9	19.64	+ .26
16	26.46	20.1	19.79	+ .31
17	26.91	19.8	19.66	+ .14
18	26.57	19.5	19.15	+ .35
19	27.45	20.4	20.23	+ .17
20	27.13	20.4	20.58	— .18

Collected March 27, 1891.

1	----	19.8 19.8	20.14	— .34
2	----	20.7 20.7	20.98 20.99	— .28
3	----	21.0 21.3	21.37 21.39	— .22
4	----	19.2 19.5	19.76 19.66	— .36
5	----	20.7 20.4	20.27 20.45	+ .19
6	----	22.8 23.1	22.66 23.08	+ .08
7	----	21.0 21.0	20.94 21.00	+ .03
8	----	18.3 18.3	18.25 18.26	+ .04
9	----	18.3 18.3	18.21 18.46	— .03
10	----	20.4 20.4	20.57 20.58	— .17

Collected April 23d, 1891.

1	27.15	20.4 20.7	20.51	+ .04
4	26.77	20.1 20.4	20.35	— .10
5	26.74	20.7	20.74	— .04
6	27.67	22.2	22.26	— .04

Collected April 23d, 1891.

7	29.71	23.4 23.4	23.81	— .41
8	28·53	21.3 2 1.6	21.60	— .15
9	26.48	19.8	20.36	— .56
10	28.78	21.9	22.16	— .26
11	27.91	20.7 20.1	20.42	— .02
13	27.42	21.0	20.80	+ .20
14	27.77	21.0	20.97	+ .03

Results.—The average quantity of fat as determined in the fifty tests above given, by the Babcock method was 20.46 per cent. and by the gravimetric or standard method was the same, 20.46 per cent.

In 26 cases the former gave a higher result than the latter, in 24 cases the reverse was true.

In 18 cases the variation of the two methods was a tenth of one per cent. or less; in 35 cases the variation was less than a quarter of one per cent.; in 7 cases the difference exceeded a third of one per cent. and the extreme difference was .56 per cent. The same facts may be expressed as follows:

In 36 per cent. of the tests the variation from the standard method was not more than one-tenth of a per cent.

In 70 per cent. of the tests the variation from the standard method was not more than a quarter of a per cent.

In 86 per cent. of the tests the variation from the standard method was not more than a third of a per cent.

In 98 per cent. of the tests the variation from the standard method was not more than a half of a per cent.

In considering these figures and the accuracy of the method it must be borne in mind that the per cent. of fat is from four to six times as great in cream as in milk and hence a larger difference in the percentage of fat found in cream by the two methods may not involve any larger proportion of the total quantity of butter fat than a much smaller difference in the per cent. of fat found in milk by the two methods involves in the total quantity of the fat of milk.

To illustrate. If a sample of milk contains 4 per cent. of fat and the Babcock method shows 3.92, the agreement is all that could be desired. The per cent. difference is only .08. That is out of 4 pounds of fat .08 of a pound or 2 per cent. is missing. Now if a sample of cream contains 20 per cent. of fat and the

Babcock method shows 19.60, the per cent. difference is .40 which is five times as large as in the case of milk. Yet *proportionally* no more fat is lost than in milk, i. e., two per cent.

In more than four-fifths of the cases above cited the error is considerably less than this.

The results above given lead us to believe that the Babcock method may be made of very great value to cream-gathering creameries. It offers to them a practicable and accurate method of ascertaining the actual quantity of butter fat which each patron furnishes so that payments may be based not on volume of cream supplied but on *actual butter fat*, which is the raw material that the creamery manufactures. This is obviously the most satisfactory method of payment. For this purpose each patron's cream should be weighed and sampled and the fat in it determined by the method described.

Since the work above described was done, Mr. J. M. Bartlett of the Maine Experiment Station, has published * a description of two new forms of testing bottles for cream, graduated from 0–25 and from 0–35 per cent. respectively. He also finds that the pipette used for milk can be used as well for cream if graduated to 18 cc.

The result of 19 tests made by him showed very good agreement with the gravimetric test.

The use of a pipette, in which the cream is drawn to a mark on the stem rather than to fill the pipette, is a very great advantage and renders possible the use of antiseptics with the cream where necessary.

A few experiments made in the laboratory of this Station with the 18 cc. pipette and flasks of the same size and shape as the flask used for milk tests,—*except that the graduated portion, while of the same length had three times the capacity of the graduated part of the ordinary flasks*—have given the following results: In column A are percentages found by the use of apparatus described on page 115, in column B the percentages found in the same samples, using for the determinations an 18 cc. pipette and the flasks just described with the larger graduated part.

A.	B.
18.00	17.95
21.90	21.70
18.60	19.00
21.60	21.40
20.40	20.80
22.20	22.60

* Mo. Expt. Station, Bull. 3, Second Series, Sept. 1, 1891.

The accuracy of the determination of fat in cream by the Babcock method is beyond any doubt.

The questions which remain to be settled are, first, can cream in considerable quantity be accurately sampled, secondly, can composite samples of cream be kept for a week at any season of the year and the fat accurately determined at the end of that time, and thirdly, is it necessary each day to take a portion of the cream for the composite sample which shall bear relation to the total quantity of cream it represents, or is it sufficiently accurate to take each day for the composite sample, the same quantity of each patron's cream.

The Station began experiments on these points as promised in Bulletin 105, but the work has been necessarily interrupted for a time.

On Variations in the Composition of Cream Raised by Deep Setting at Low Temperatures.

The following observations were made on cream collected from creamery patrons who set their milk in deep submerged cans where it stood from 12 to 24 hours before collection by the cream-gatherer. The samples were drawn from mixtures of the cream of morning and evening setting.

SOLIDS.—Thirty-seven tests made at two creameries gave an average of 27.55 per cent. of solids. The highest per cent. found was 31.18, the lowest 25.18.

BUTTER FAT.—One hundred and sixty-five tests made at three creameries in different parts of the State gave for the average 19.85 per cent. of fat. The highest per cent. found was 24.9, the lowest 13.8 per cent.

The widest variations in the per cent. of fat in the cream furnished by individual patrons of one creamery on the same day were 13.8–21 per cent. and in another case 18.3–24.9 per cent. The smallest daily variations at any one creamery were 19.0–21.9 per cent.

The Composition of Cream and Butter-milk and the Loss of Butter-Fat in Churning.

Through the courtesy of the superintendent of one of the creameries in the State the following test was made:

All the work of making the butter was done in the usual way by the butter-maker; the station chemists weighed the cream and products of the churning and analyzed them.

There went into the churn 467.5 pounds of ripened cream and 12 pounds of water. After churning there were added in two different portions 116.5 pounds of water for washing the butter. The two washings were separately weighed and analyzed.

ANALYSES OF THE CREAM AND PRODUCTS OF CHURNING.

	Cream.*	Butter-milk.	First washing.	Second washing.	Butter.
Ash	.60	.67	.24	.21	5.22†
Albuminoids	2.75	3.31	2.56	1.14	1.62
Fat	18.33	.20	.10	.07	79.81
Sugar	3.80	4.35	3.90	1.90	....
Water	74.52	91.47	93.20	96.68	15.35
	100.00	100.00	100.00	100.00	100.00

The next table shows the number of pounds of each of these ingredients which went into the churn and the quantity of each that went into the butter, the butter-milk and the washings.

CHURNING ACCOUNT.

Taken out of the Churn.	Ash. Pounds.	Albuminoids. Pounds.	Fat. Pounds.	Sugar. Pounds.	Water. Pounds.
Butter-milk 238 pounds	1.59	7.88	.48	10.35	217.70
First washing, 167½ pounds	.40	4.29	.17	6.53	156.11
Second washing, 68½ pounds	.14	.78	.05	1.30	66.23
Butter [salted], 108½ pounds	3.49	1.76	86.59	....	16.65
Water lost in working butter	....	....	....	....	17.11
	5.62	14.71	87.29	18.11	456.69
Put into the churn, cream and water	2.88	13.19	87.89	18.22	473.8

The excess of "ash" in the products of the butter, 2.74 pounds, is the salt added in working. The 1.52 pounds of albuminoids appearing as taken out of the churn in excess of what was put in is to be charged to errors and losses in weighing.

There is a loss of .11 pounds of sugar to be explained in the same way. Of the 87.89 pounds of butter-fat put into the churn, .60 pounds were lost in the butter-milk and washings. This amounts to .68 of one per cent. of the total quantity of fat.

* Includes the 12 pounds of water added before churning. † Salt.

BUTTER ANALYSES.

In a following table are given the analyses of eleven samples of butter from private dairies and six samples of creamery butter. These butters were entered in the exhibit at the Connecticut Dairymen's Association which met in Hartford, January 20–22, 1891. The score of points for each butter is also given. The method of making award was as follows: Number of possible points, 100. Minimum number allowed in awarding premiums 85. Divide the total premium by the total number of points scored above the minimum. The quotient is the amount to be awarded for each point scored above the minimum.

To illustrate: Of the creamery butters,

No. 9 scored 14 points above the minimum.
" 7 " 14 " "
" 4 " 10 " "
" 1 " 4 " "
" 5 " 3 " "
" 6 " 0 " "

Total points scored..... 45. Total premium to be divided, $70.00. Each point scoring above the minimum therefore gets $\frac{70}{45} = \$1.555$ and the premiums awarded are as follows:—

No. 9 and No. 7, each $21.78, No. 4, $15.55, No. 1, $6.22 and No. 5, $4.67.

PRIVATE DAIRY BUTTER.

Scale of Points.

	Perfect.	No. 5.	No. 11.	No. 4.	No. 6.	No. 7.	No. 2.	No. 1.	No. 8.	No. 9.	No. 3.	No. 10.
Flavor..	50	48	45	46	44	40	47	30	21	20	20	15
Grain...	25	23	23	23	22	23	22	24	17	15	15	5
Color...	15	15	15	12	12	12	6	15	14	13	13	3
Salt	5	5	4	4	5	3	3	4	4	3	1	1
Package.	5	5	4	5	5	5	1	5	0	4	3	0
Total...	100	96	91	90	86	83	79	78	56	55	52	24

Analyses.

Water.....	10.86	11.01	12.27	8.59	12.74	11.54	10.09	10.99	10.04	9.37	11.38
Curd	1.32	1.28	.91	1.44	1.42	2.00	1.83	2.53	.94	1.24	1.11
Salt	1.86	5.23	1.18	2.32	2.76	4.11	4.22	3.47	2.44	7.83	6.78
Fat	85.96	82.48	85.64	87.65	83.08	82.35	83.86	82.01	86.58	81.56	80.73
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Specific gravity of the butter-fat at 100° C.....	.8666	.8644	.8667	.8646	.8646	.8657	.8640	.8642	.8652	.8650	.8661

Creamery Butter.

Scale of Points.

	Perfect.	No. 9.	No. 7.	No. 4.	No. 1.	No. 5.	No. 6.
Flavor	50	49	50	48	46	49	44
Grain	25	25	25	23	22	21	21
Color	15	15	14	15	13	10	9
Salt	5	5	5	4	3	3	3
Package	5	5	5	5	5	5	5
Total	100	99	99	95	89	88	82

Analyses.

Water	11.38	8.89	11.38	7.97	8.35	6.54
Curd	.96	.94	1.18	.90	1.00	1.58
Salt	2.65	2.14	3.17	2.88	2.30	3.96
Fat	85.01	88.03	84.27	88.25	88.35	87.92
	100.0	100.0	100.0	100.0	100.0	100.0
Specific gravity of the butter-fat at 100° C.	.8644	.8648	.8647	.8644	.8645	.8646

The judge of the creamery butter was Mr. H. K. House of the Allyn House, Hartford ; of the private dairy butter, Mrs. Thomas Fairclough, of Waterbury. Tunxis Creamery, Robertsville, and Green's Farms Creamery, Westport, took first premiums.

The average composition of the creamery and private dairy butters and the range of percentage of each ingredient are as follows:

	Creamery Butter.		Private Dairy Butter.	
	Range of percentage.	Average composition.	Range of percentage.	Average composition.
Water	6.5–11.4	**9.1**	8.6–12.7	**10.8**
Curd	.9– 1.6	**1.1**	.9– 2.5	**1.5**
Salt	2.1– 4.0	**2.9**	1.2– 7.8	**3.8**
Fat	84.3–88.4	**86.9**	80.7–87.7	**83.9**
		100.0		**100.0**

The private dairy butters which received the lowest grading for flavor, grain and salt were ones which had the very abnormally high per cents. of salt (6.78 and 7.83).

It is somewhat surprising that No. 11, with 5.23 per cent. of salt, should have scored as high as it did.

The creamery butter as a rule carried 3 per cent. more of actual butter-fat than the private dairy butter.

PROTEIDS OR ALBUMINOIDS OF THE OAT-KERNEL.

SECOND PAPER.*

BY THOMAS B. OSBORNE, PH.D.

I. PREPARATION OF A GLOBULIN FROM THE SO-CALLED ALBUMINATE.

In a paper on the proteids of the oat-kernel published in the Report of this Station for 1890, the writer described a globulin obtained from the oat-kernel by extraction with a ten per cent. sodium chloride brine heated to 65° C. [Preparation **20**]. It was shown that this globulin differs from that extracted by the same brine at 20° C. both in properties and composition and that on cooling the warm saturated solution of this body in dilute sodium chloride brine, crystals were several times obtained; once in the form of rhombohedra and at other times in the form of octahedra.

This globulin has been further investigated and the results obtained are the main subject of this paper.

When the oat-proteids brought into solution in cold brine† are precipitated by saturating the extract with ammonium sulphate, a considerable part of this precipitate is always found to have lost its solubility in the salt-solution, by conversion into a form called by Weyl "an albuminate" [**15, 16**]. In this state it is soluble in a one per cent. solution of sodium carbonate.

On treating ten pounds of freshly ground oats with brine, precipitating the filtered solution by saturating with ammonium sulphate and extracting the precipitate thus obtained with brine, it was found that a very large part of the globulin originally dis-

* Read at the meeting of the National Academy of Sciences in New York Nov. 10, 1891.

† Unless otherwise specified "brine" and "salt-solution" are to be understood in this paper to signify aqueous solutions of very pure sodium chloride containing ten per cent. of NaCl, used at common temperatures.

solved was converted into the so-called "albuminate." After washing this latter thoroughly with brine, to free it completely from the unchanged globulin, it was dissolved in a one per cent. sodium carbonate solution. About two-thirds of this solution was then treated with carbon dioxide for three hours, whereby a heavy white precipitate settled out. This precipitate was collected on a filter and allowed to drain over night. The next morning it was found to have become transparent and gummy about the edges.

This precipitate was now completely soluble in salt-solution and had all the properties of the globulin [**20**] formerly obtained from the hot sodium chloride extract. The entire precipitate was then dissolved in one liter of brine and dialyzed for four days, during which time all but a trace of the substance separated out. The thus precipitated proteid was seen under the microscope to consist of spheroids of about one-tenth of a millimeter diameter or less, similar to those obtained by cooling a warm solution of the globulin, as described in my former paper. After filtering off, washing with alcohol, ether and absolute alcohol, twenty-one grams of air-dried material were obtained. This substance was completely soluble in brine and was precipitated therefrom by diluting with water or saturating with sodium chloride, or by adding minute quantities of hydrochloric, nitric or acetic acids.

In the entire absence of salts, extremely small amounts of the just named acids dissolved the proteid instantly and completely, but the addition of a little sodium chloride precipitated it from this solution, the extent of the precipitation depending on the relative quantities of the acid and salt present. The precipitation was complete when certain proportions of salt and acid were used. Addition of strong soda-lye to the solution of the proteid in dilute acid, gave a heavy precipitate, which dissolved but slowly in excess of soda, although the final mixture contained over twenty-five per cent. of sodium hydrate. Addition of copper sulphate to this alkaline solution gave the biuret violet. With Millon's reagent and with nitric acid the usual proteid reactions were obtained. Alcohol containing a minute amount of free acid dissolved the substance completely. Its composition was found to be as follows:

OAT PROTEID.—*Derived from Sodium Carbonate Solution of the "Albuminate."*

PREPARATION 21.

			Ash-free.	
	I.	II.	I.	II.
Carbon	52.28	----	52.30	----
Hydrogen	6.98	----	6.98	----
Nitrogen	17.86	17.73	17.86	17.73
Sulphur	0.69	----	0.69	----
Oxygen	----	----	22.17	----
Ash	0.03	----	----	----
			100.00	

Ash.—0.6759 gram substance dried at 110° C. gave 0.0002 gram of ash = 0.03 per cent.

Carbon and hydrogen.—0.4610 gram dried substance gave 0.8837 gram CO_2 = 52.28 per cent. C., and 0.3220 gram H_2O = 6.98 per cent. H.

Nitrogen.—I. [Dumas method].—0.3474 gram dried substance gave 52.15 cc. N_r at 13° C. [barometer 768.2 mm. at 23° C.] = 17.86 per cent. N.

II.—Kjeldahl method].—1.0108 gram dried substance gave ammonia = 21. 8cc. HCl sol. [1 cc. = 0.00822 gram N.] = 17.73 per cent. N.

Sulphur.—0.7695 gram dried substance gave 0.0380 gram $BaSO_4$ = 0.0052 grams S = 0.69 per cent.

In all respects save one this substance behaved exactly like the globulin obtained by extracting ground oats with hot sodium chloride solution. The latter proteid dissolved to a turbid solution in cold, and to a perfectly clear solution, in hot distilled water. So far as the usual methods of analysis show, the two bodies are identical in composition as is seen from the following figures:

	GLOBULIN.—Extracted from oats by hot sodium chloride solution. Average of two analyses. Preparation 20.	GLOBULIN.—Derived from sodium carbonate solution of the "Albuminate." Preparation 21.
Carbon	52.22	52.30
Hydrogen	6.98	6.98
Nitrogen	17.82	17.86
Sulphur	0.77	0.69
Oxygen	22.21	22.17
	100.00	100.00
Ash	0.19	0.03

Another preparation of this substance was made by dissolving a second portion of the "albuminate" in two per cent. sodium carbonate solution, precipitating with carbon dioxide, washing thoroughly with water, dissolving in brine and diluting the solu-

tion with a large amount of water. The final snow-white precipitate was filtered off and, after washing with alcohol and ether, weighed eleven grams. Its properties are exactly the same as those of **20** except that it is slightly soluble in hot distilled water. Its composition, as determined by analysis, here follows:

OAT PROTEID.—*Derived from Sodium Carbonate Solution of the "Albuminate."*

PREPARATION **22.**

		Ash-free.
Carbon	51.98	52.05
Hydrogen	6.92	6.93
Nitrogen	17.83	17.85
Sulphur } Oxygen }	----	23.17
Ash	0.13	----
		100.00

Ash.—0.5437 gram substance dried at 110° C. gave 0.0007 gram ash =0.13 per cent.

Carbon and hydrogen.—0.5789 gram dried substance gave 1.1030 gram CO_2= 51.98 per cent. C and 0.3609 gram H_2O=6.92 per cent. H.

Nitrogen.—0.4230 gram dried substance gave 63 cc. N at 13° C. [barometer 773 mm. at 23° C.] = 17.83 per cent. N.

The filtrate from the precipitate produced by carbon dioxide in the preparation of the preceding substance [**22**] was diluted with an equal volume of water, further treated with carbon dioxide for about three hours and allowed to stand over night. The resulting precipitate was filtered off and washed with water, alcohol and ether. Five grams of substance having the same properties as preparations **21** and **22** were thus obtained. Analysis of this preparation gave the following results:

OAT-PROTEID.—*Derived from Sodium Carbonate Solution of the "Albuminate."*

PREPARATION **23.**

		Ash-free.
Carbon	52.16	52.35
Hydrogen	7.00	7.02
Nitrogen	17.68	17.73
Sulphur	0.73	0.73
Oxygen	----	22.17
Ash	0.36	----
		100.00

Ash.—0.5500 gram substance dried at 110° C., gave 0.0020 gram of ash = 0.36 per cent.

Carbon and hydrogen.—0.4388 gave dried substance gave 0.8393 gram CO_2= 52.16 per cent. C., and 0.2766 gram H_2O = 7.00 per cent. H.

Nitrogen.—0.3659 gram dried substance gave 54.36 cc. N, at 13° C. [barometer 767.6 mm. at 22° C.] = 17.68 per cent. N.

Sulphur.—0.9135 gram of dried substance gave 0.0484 gram $BaSO_4$ = 0.0066 gram S = 0.73 per cent. S.

II. Crystalization of the Globulin obtained from the so-called Albuminate.

Three hundred cubic centimeters of one per cent. sodium chloride solution were heated to 70° C. with 5 grams, i. e. an excess, of preparation **21**, and filtered on a steam-jacketed funnel. On cooling, the filtrate rapidly deposited a large crop of rhombohedral crystals. The residue undissolved by the hot one per cent. brine was washed with the same weak brine heated to 70°. On cooling, the washings deposited octahedral crystals. This process was repeated several times with other portions of preparation **21**. In most cases the filtrate deposited rhombohedral and the washings octahedral crystals. The residues which had been filtered out were dissolved and crystallized as far as possible from one per cent. brine, yielding either octahedral crystals or mixtures of octahedra and rhombohedra. The different crops of crystals were collected on separate filters according as they were wholly rhombohedra or octahedra or mixtures of the two. Three preparations, **24, 25, 26,** were obtained in this way, which were, as usual, washed with water, alcohol and ether and dried at 110° for analysis. Thus prepared, they retained their crystalline form entirely unchanged and had in all respects the same properties as the mother substance, **21**.

Prof. S. L. Penfield kindly examined these crystals and states that they appear to be rhombohedra and octahedra although the former have no action on polarized light. He suggests that the apparent rhombohedra may be octahedra with but six faces developed, such crystals occurring in nature. As they were too small for measurement [less than one-tenth of a millimeter long], this point could not be definitely determined. Analyses of the three preparations gave the following results:

CRYSTALLIZED OAT-PROTEID, *derived from* **21**.

PREPARATION **24**.

		Ash-free.
Carbon	52.14	52.17
Hydrogen	6.96	6.96
Nitrogen	17.92	17.93
Sulphur	0.53	0.53
Oxygen	----	22.41
Ash	0.06	----
		100.00

Ash.—0.4600 gram substance dried at 110° C. gave 0.0003 gram of ash = 0.06 per cent.

Carbon and hydrogen.—0.4463 gram dried substance gave 0.8835 gram CO_2 = 52.14 per cent. C., and 0.2795 gram H_2O = 6.96 per cent. H.

Nitrogen.—0.4042 gram dried substance gave 63.0 cc. N. at 17° C. [barometer 756.3 mm. at 21° C.] = 17.92 per cent. N.

Sulphur.—0.6345 gram dried substance gave 0.0242 gram $BaSO_4$ = 0.0033 gram S = 0.53 per cent.

CRYSTALLIZED OAT-PROTEID, *derived from* **21**.

PREPARATION **25**.

		Ash-free.
Carbon	52.00	52.11
Hydrogen	7.09	7.10
Nitrogen	17.91	17.94
Sulphur	----	22.85
Oxygen	----	
Ash	0.20	----
		100.00

Ash.—0.2035 gram substance dried at 110° C. gave 0.0004 gram ash = 0.20 per cent.

Carbon and hydrogen.—0.2562 gram dried substance gave 0.4885 gram CO_2 = 52.00 per cent C., and 0.1635 gram H_2O = 7.09 per cent. H.

Nitrogen.—0.3935 gram dried substance gave 61.3 cc. N. at 17° C. [barometer 756.5 mm. at 21° C.] = 17.91 per cent. N.

CRYSTALLIZED OAT-PROTEID, *derived from* **21**.

PREPARATION **26**.

		Ash-free.
Carbon	52.23	52.25
Hydrogen	7.08	7.08
Nitrogen	17.81	17.82
Sulphur	0.52	0.52
Oxygen	----	22.33
Ash	0.05	----
		100.00

Ash.—0.3974 gram substance dried at 110° C. gave 0.0002 gram of ash = 0.05 per cent.

Carbon and hydrogen.—0.2866 gram dried substance gave 0.5489 gram CO_2 = 52.23 per cent. C., and 0.1828 gram H_2O = 7.08 per cent. H.

Nitrogen.—0.3123 gram dried substance gave 48.31 cc. N. at 17° C. [barometer 757.0 mm. at 21° C] = 17.82 per cent. N.

Sulphur.—0.3598 gram dried substance gave 0.0135 gram $BaSO_4$ = 0.0018 gram S = 0.52 per cent.

CRYSTALLIZED OAT-GLOBULIN *derived from* **21.**

	24. Rhombohedra.	**25.** Rhomboheda and Octahedra.	**26.** Octahedra.
Carbon	52.17	52.11	52.25
Hydrogen	6.96	7.10	7.08
Nitrogen	17.93	17.94	17.82
Sulphur	0.53	22.85	0.52
Oxygen	22.41		22.33
	100.00	100.00	100.00
Ash	0.06	0.20	0.05

No chlorine could be detected in these crystals. It is thus shown that the crystallized globulin, except for its slightly lower content of sulphur, has the same composition as the mother-substance and agrees in all respects with the globulin obtained directly from ground oats by extraction with hot salt solution and described in my former paper, except that it is not soluble in water and contains a little less sulphur.

It is further to be noted that the methods of preparation were suited to fractionally separate the substance into its component parts had it been a mixture of two or more globulins. It seems improbable that the sodium chloride which Grübler found in his crystallized globulin from squash seed was anything more than an accidental impurity. The ash of Grübler's preparations contained traces of the various salts present in the solutions from which they separated, and since the content of total mineral matters is variable and, as in my preparations **24** and **26**, sometimes amounts to but .05 per cent. of the proteid, there appears to be no good ground for Grübler's assumption that crystallized proteids are definite compounds of globulin with sodium chloride or with other inorganic bodies.

III. Globulin obtained from Ground Oats by direct Extraction with Sodium Carbonate Solution.

One hundred grams of ground oats were digested with a one per cent. sodium carbonate solution, the extract was filtered clear and the sodium carbonate converted into bicarbonate by treatment with carbon dioxide. The solution was then saturated with ammonium sulphate and the heavy precipitate filtered off. This precipitate was washed with a saturated solution of ammonium sulphate until the washings no longer reacted alkaline. The precipitate was then extracted thoroughly with salt solution and this extract dialyzed. After removal of the salts, by dialysis, the proteid, which had separated, was filtered off and washed with alcohol and ether. It weighed, air-dry, one and a half grams, being, therefore, about one and a half per cent. of the oat kernel. Dried at 110° for analysis it was found to have the following composition:

Oat Proteid.—*Extracted from ground oats by Sodium Carbonate Solution and Soluble in Sodium Chloride Solution.*

Preparation 27.

			Ash-free.	
	I.	II.	I.	II.
Carbon	51.68	----	51.82	----
Hydrogen	6.91	----	6.93	----
Nitrogen	17.92	17.91	17.95	17.94
Sulphur	----	----	23.30	----
Oxygen	----			
Ash	0.26		----	----
			100.00	

Ash.—0.2652 gram substance dried at 110° C. gave 0.0007 gram ash = 0.26 per cent.

Carbon and Hydrogen.—0.2296 gram dried substance gave 0.4350 gram CO_2 = 51.68 per cent. C and 0.1429 gram H_2O = 6.91 per cent. H.

Nitrogen, I.—0.3441 gram dried substance gave 52.15 cc. N at 13° C. [barometer 764.0 mm. at 25° C.]=17.92 per cent. N.

II.—0.3294 gram dried substance gave 50.14 cc. N at 14° C. [barometer 762.0 mm. at 23° C.=17.91 per cent. N.

From this analysis it is seen that this body is the same as that obtained from the oats by direct extraction with hot salt-solution, as well as from the "albuminate" by the methods just described.

IV. Summary of Analyses of Oat-Globulin.

The agreement of the analyses of the different preparations of the Oat-Globulin may be seen from the following table:

	20	21	22	23	24	25	26	27
Carbon.....	52.22	52.30	52.05	52.35	52.17	52.11	52.25	51.82
Hydrogen ..	6.98	6.98	6.93	7.02	6.96	7.10	7.08	6.93
Nitrogen ...	17.82	17.86	17.85	17.73	17.93	17.94	17.82	17.95
Sulphur	0.76	0.69	23.17	0.73	0.53	22.85	0.52	23.30
Oxygen.....	22.22	22.17		22.17	22.41		22.33	
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The writer has found nowhere any description of a vegetable proteid like this. Although its proportion of carbon is the same as that of the globulin extracted from oats by cold salt-solution, its nitrogen-content is one per cent. greater. It contains nearly a per cent. less of nitrogen, about one half per cent. more of carbon and but one-half as much sulphur as Chittenden & Hartwell* found in the globulin or "vegetable vitellin" of squash-seed.

Barbieri's analysis of squash-seed globulin agrees fairly well with these analyses of the crystallized oat-globulin, but carbon and sulphur are somewhat lower, nitrogen higher and as regards sulphur and nitrogen his analysis differs materially from the later ones of Chittenden & Hartwell.

Grübler's earlier analyses of squash-seed globulin which gave 53.21 per cent. of carbon and 19.22 per cent. of nitrogen were evidently incorrect, and in a recent publication† this chemist states the composition of crystallized proteid from squash-seed as given below, where the various analyses of vegetable globulin, except the earlier ones of Grübler, are tabulated.

I have obtained from flax-seed a crystallized globulin whose composition agrees quite nearly with that of the squash-seed vitellin.

The following table gives the composition of crystallizable globulin from various seeds:

COMPOSITION OF CRYSTALLIZABLE VEGETABLE GLOBULIN.

Ritthausen.			Barbieri.	Ritth.	Chittenden & Hartwell.			Grübler	Osborne.	
					Squash seed.					
Hemp cryst.	Castor bean cryst.	am'ph.	cryst.	cryst.	sphe-roid.	am'ph.	cryst.	Flax seed cryst.	Oats cryst.
C	50.98	50.88	51.88	51.61	51.60	52.03	51.81	51.48	51.36	52.18
H.....	6.92	6.98	7.51	7.00	6.97	6.93	6.94	6.76	6.94	7.05
N.....	18.73	18.58	18.08	....	18.80	19.08	18.71	18.14	18.66	17.90
S.....	0.82	0.77	0.60	....	1.01	1.04	1.01	0.96	0.82	0.53
O.....	22.55	22.79	21.93	....	21.62	20.92	21.53	22.66	22.22	22.34
	100.00	100.00	100.00	....	100.00	100.00	100.00	100.00	100.00	100.00
Ash.....		....	1.11	....	0.30	0.36	....	0.18	....	....

* Journal of Physiology, **XI**, pp. 437–440. † Jour. für prak. Chemie, **XLIV**, 369.

V. Proteid extracted from ground Oats by direct Treatment with Alkali Carbonate.

The precipitate produced by saturating with ammonium sulphate the sodium carbonate extract of the oats from which the globulin 27 had been extracted, was next washed with warm eighty per cent. alcohol until all the proteid soluble in that liquid was removed. The residue was then found to be insoluble in one per cent. sodium carbonate solution and was therefore dissolved in two-tenths per cent. caustic potash solution, filtered and the dissolved proteid completely precipitated by neutralizing with dilute acetic acid. After washing the latter with water, alcohol and ether and drying at 110° its composition was as follows :

Oat Proteid.—*Extracted from ground Oats by Sodium Carbonate Solution.*
Preparation 28.

			Ash-free.	
	I.	II.	I.	II.
Carbon	53.25	....	53.63	....
Hydrogen	7.13	....	7.18	....
Nitrogen	15.99	15.89	16.11	16.01
Sulphur	0.81	....	0.82	....
Oxygen	....	....	22.26	....
Ash	0.72	....	....	....
			100.00	

Ash.—0.5661 gram substance dried at 110° C. gave 0.0041 gram ash = 0.72 per cent. ash.

Carbon and hydrogen.—0.3269 gram dried substance gave 0.6383 gram CO_2 = 53.25 per cent. C, and 0.2096 gram H_2O = 7.13 per cent. H.

Nitrogen.—I. 0.3637 gram dried substance gave 49.33 cc. N at 13° C. (barometer 761.5 mm. at 25° C.) = 15.99 per cent. N.

II. 0.3916 gram dried substance gave 52.95 cc. N at 13° C. (barometer 759.2 mm. at 23° C.) = 15.89 per cent. N.

Sulphur.—0.5000 gram dried substance gave 0.0295 gram $BaSO_4$ = 0.0041 gram S = 0.81 per cent. S.

If this analysis is compared with that of preparation 17, which was obtained from ground oats by direct extraction with two-tenths per cent. potash solution, it will be seen that the two agree quite closely.

	28.	17.
Carbon	53.63	53.49
Hydrogen	7.18	7.01
Nitrogen	16.11	16.39
Sulphur	0.81	0.99
Oxygen	22.27	22.12
	100.00	100.00
Ash	0.72	1.00

These two bodies are thus shown to be essentially the same in composition and the results of direct extraction with alkali given in the previous paper are confirmed.

VI. Conclusions.

The proteids of the oat kernel undergo great change in contact with water or sodium chloride solution. The body extracted by direct treatment of ground oats with alcohol differs much in properties and composition from that extracted by alcohol after the ground oats have had contact for some time with water or sodium chloride solution.

Direct treatment with sodium carbonate solution yields the same globulin as that obtained by direct treatment with hot sodium chloride solution, but a different globulin from that obtained by direct treatment with cold sodium chloride solution. Sodium carbonate solution also extracts another proteid the same as that yielded by direct extraction with dilute potash-lye which, again, is distinct in composition from that obtained after the oats have been in contact with water. It is remarkable that all these transformations are the result of the use of water or salt-solution as contrasted with the use of three agents known to suspend or destroy ferment-action, viz: alcohol, alkali or heat.

The fact that the globulin extracted after treatment of the ground oats with alcohol has the same composition as that obtained by direct treatment with sodium chloride, would indicate that alcohol temporarily suspends a ferment-action which is induced by water or solutions of neutral salts.

It is probable that the primary proteids originally contained in the oat-kernel are the three following bodies:

Primary Oat-Proteids.

	Alcohol-soluble Proteid. Average of five analyses.	Salt-soluble Proteid or Globulin. Average of nine analyses.	Alkali-soluble Proteid. Average of two analyses.
Carbon	53.01	52.19	53.56
Hydrogen	6.91	7.00	7.09
Nitrogen	16.43	17.86	16.20
Sulphur	2.26	0.65	0.90
Oxygen	21.39	22.30	22.25
	100.00	100.00	100.00

Of the above substances the alcohol-soluble proteid forms about one and a quarter per cent., the globulin about one and a half

per cent., and the alkali-soluble body the remainder of the proteids contained in the oat-kernel, with the possible exception of extremely small amounts of proteose and acid-albumin. The two latter substances are quite probably the results of change occurring during extraction; the evidence, however, on this point is not conclusive.

Three other proteids are obtained evidently by the alteration of the primary proteids, and probably through ferment-action, when the ground-oats are subjected to contact with water or solutions of neutral salts. The composition of these derived or secondary proteids is as follows:

SECONDARY OAT-PROTEIDS.

	ALCOHOL-SOLUBLE PROTEID. Average of four analyses.	SALT-SOLUBLE PROTEID OR GLOBULIN. Average of four analyses.	ALKALI-SOLUBLE PROTEID. Average of two analyses.
Carbon	53.70	52.34	52.49
Hydrogen	7.00	7.21	7.10
Nitrogen	15.71	16.88	17.11
Sulphur	1.76	0.88	0.80
Oxygen	21.83	22.69	22.50
	100.00	100.00	100.00

It would appear that none of the proteids from the oat-kernel have been obtained and analyzed in a state of purity by previous investigators. The author therefore reserves the right to revise the nomenclature of these bodies, after further progress in his researches on the other vegetable proteids, with which he is now engaged.

THE PROTEIDS OF THE MAIZE KERNEL.*

By Professor R. H. Chittenden and Dr. Thomas B. Osborne.

1. The maize kernel contains several distinct proteids well characterized in reactions and composition. Of these there are three globulins, and one or more albumins, all occurring in small proportion and an alcohol-soluble proteid which is relatively abundant.

2. The substance obtainable from the maize kernel by extraction with 10 per cent. solution of sodium chloride and separation by dialysis, or by precipitation with ammonium sulphate, followed by dialysis—is mainly a mixture of two globulins, differing from each other in composition and in coagulation points.

3. The mixed globulins can be approximately separated from each other by fractional heat-coagulation or by deposition from warm dilute salt-solution. In the former process there is formed a small amount of proteose-like bodies.

4. The two globulins separable by the above methods, are a myosin-like body and a vitellin-like body.

The myosin-like globulin agrees closely in composition with animal myosin as shown by the following analyses. It has, however, a coagulation point (in 10 per cent. sodium chloride solution) of about 70° C.

	Maize Myosin. Average of two analyses.	Animal Myosin. Average of analyses of 13 preparations from various sources.
Carbon	52.66	52.82
Hydrogen	7.02	7.11
Nitrogen	16.76	16.77
Sulphur	1.30	1.27
Oxygen	22.26	22.03
	100.00	100.00

The vitellin-like globulin is almost entirely non-coagulable by heat, when dissolved in dilute salt-solutions. It is more soluble in warm than in cold salt-solutions and when separated from the

* This paper is a brief summary of the results of an extended investigation of the Proteids of Indian Corn carried on during 1890 and 1891, in the Sheffield Biological Laboratory of Yale University. The full details of the research are printed in the *American Chemical Journal*, vol. xiii, pp. 453–468 and pp. 529–552, and vol. xiv, pp. 20–44. The Indian Corn used was the White Dent variety raised on the farm of Mr. J. H. Webb, near New Haven, and was freshly ground at this Station as required.

former, either by cooling the fluid or on dialysis, almost invariably appears in the form of small spheroids.

It has the following composition :

MAIZE VITELLIN.

	Average of six analyses.
Carbon	51.71
Hydrogen	6.85
Nitrogen	18.12
Sulphur	0.86
Oxygen	22.46
	100.00

5. These two globulins exist as such in the maize kernel, as is evident from the coagulation points of their salt-solution, from the fact that their separation can be accomplished without the aid of heat; and lastly since it is possible to extract the individual globulins directly from the kernel by the use of appropriate solvents.

6. Direct extraction of the finely powdered maize meal with water yields a dilute salt-solution which dissolves the myosin, leaving the bulk of the vitellin undissolved. Probably the character of the salts present in the kernel plays an important part in this separation. From this solution the myosin can be separated in a fair degree of purity by the usual methods.

7. Extraction of maize meal with 10 per cent. sodium chloride solution, after previous extraction with water, dissolves the vitellin, which can be separated from this solution by the customary methods. So prepared it agrees exactly in composition with the vitellin separated by heat-coagulation from the mixed globulins.

8. The third globulin present in the maize kernel is characterized by extreme solubility in very dilute salt-solutions, especially of phosphates and sulphates. It separates from such solutions only by prolonged dialysis, i. e., not until nearly every trace of the salts has been removed. It coagulates in a 10 per cent. sodium chloride solution in the neighborhood of 62° C. and has the following composition :—

MAIZE GLOBULIN.

Highly soluble.

Carbon	52.38
Hydrogen	6.82
Nitrogen	15.25
Sulphur	1.26
Oxygen	24.29
	100.00

9. Through the long continued action of water and also of strong solutions of salts, as ammonium sulphate, the myosin and the globulin noticed in the preceding paragraph are changed into insoluble modifications, soluble however in 0.5 per cent. sodium carbonate solution, from which solution they are precipitated, on neutralization, apparently as albuminates. So prepared these insoluble modifications are characterized by a relatively high content of carbon.

10. An aqueous extract of maize meal as well as a sodium chloride extract apparently contains in addition to the globulins, two albumin-like bodies, more or less coagulable by heat, but, as prepared, unlike in chemical composition. Owing to the difficulties encountered in separating these albumins their composition could not be determined with certainty.

11. A small amount of proteose can be detected in the extracts of maize meal, after the globulins have been entirely removed, but apparently this is mainly if not wholly, an artificial product, resulting from alteration of some one or more of the preceding bodies.

12. The chief proteid in the maize kernel is the peculiar body, known as maize-fibrin or better as *Zein*, which is soluble in warm dilute alcohol, but insoluble both in water and in absolute alcohol. Zein is characterized by a high content of carbon, by its resistance to the action of dilute alkalies (i. e., non-convertibility into alkali-albuminate) and by the ease with which it is converted into an insoluble modification on being warmed with water or with very weak alcohol.

Soluble zein and its insoluble modification have the same chemical composition, as indicated by the following analyses:

	Soluble Zein. Average of six analyses.	Insoluble Zein. Average of three analyses.
Carbon	55.28	55.15
Hydrogen	7.27	7.24
Nitrogen	16.09	16.22
Sulphur	0.59	0.62
Oxygen	20.77	20.77
	100.00	100.00

OBSERVATIONS ON THE GROWTH OF MAIZE CONTINUOUSLY ON THE SAME LAND.

In 1888* this Station studied the effect of distance of planting on the quality and quantity of the maize crop.

In 1889† the experiment was repeated on the same land.

In 1890‡ the Station studied the comparative effects of planting in hills and drills on the quality and quantity of the maize crop, using for the test the plots which had been used in the two previous years.

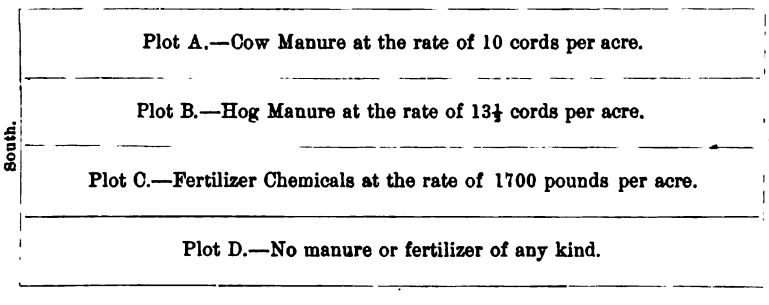
In 1891 the same land was planted to maize for the fourth season in order to observe the yield from year to year when grown continuously on the same land; contrasting the crops grown with heavy applications of manure or of fertilizer chemicals with those grown where no fertilizer of any kind was applied.

Following is a record of the results for the first year. These do not require discussion till further data accumulate. It is hoped the experiment may be carried on for a considerable number of years.

Arrangement of the Field.

The accompanying diagram will make clear the arrangement of the field in 1891 and its division into strips.

The whole piece was divided into strips identical with those figured in the Report of 1890, page 184. They are four in number running from north to south, and each one containing three-tenths of an acre. They will be referred to as Plots A B C and D.


Plot A.—Cow Manure at the rate of 10 cords per acre.
Plot B.—Hog Manure at the rate of 13½ cords per acre.
South.
North.
Plot C.—Fertilizer Chemicals at the rate of 1700 pounds per acre.
Plot D.—No manure or fertilizer of any kind.

* Report Connecticut Experiment Station, 1889, p. 9.

† Report Connecticut Experiment Station, 1889, p. 219.

‡ Report Connecticut Experiment Station, 1890, p. 184.

Fertilizers and Manure used.

In the years 1888 and 1889 the same commercial fertilizer was applied on all the Plots and the quantity of crop removed was practically alike on all.

In 1890, Plot A received 20,925 pounds or 3.2 cords of cow manure, which is at the rate of 10.7 cords per acre.

Plot B received 21,141 pounds or 4 cords of hog manure which is at the rate of 13.3 cords per acre.

Plot C received a mixture of chemicals consisting of 100 pounds of nitrate of soda, 80 pounds of sulphate of ammonia, 80 pounds of dried blood, 125 pounds of cotton seed meal, 90 pounds dissolved bone black, and 40 pounds of muriate of potash, which is at the rate of 1700 pounds per acre.

Plot D received no fertilizers.

Analyses of the samples of manure are given on page 71, of the Report for 1890.

The following table shows the quantities of nitrogen, phosphoric acid and potash applied each year to the soil in the fertilizer and the quantities annually removed in the crops and the consequent exhaustion or enrichment of the soil. The phosphoric acid and potash in the crops of 1890 were not determined but have been assumed to have the same relation to the nitrogen of the crops as they had in the crop of 1888.

POUNDS OF NITROGEN, PHOSPHORIC ACID AND POTASH PUT ON IN FERTILIZER AND TAKEN OFF IN MAIZE CROP FOR THREE YEARS.

	Nitrogen.	Phosphoric acid.	Potash.
Put on each plot in fertilizer per acre in 1888..	45.1	107.2	77.8
Took off in crop per acre.....	94.8	39.4	50.2
Gained (+), or lost (—) by the soil in 1888....	—49.7	+67.8	+27.6
Put on each plot in fertilizer per acre in 1889..	45.1	107.2	77.8
Took off in crop	60.9	28.7	48.5
Gained or lost by the soil in 1889.....	—15.8	+78.5	+29.3
Gained or lost by the soil per acre in two years' cropping	—65.5	+146.3	+56.9
Put on Plot A in cow manure per acre in 1890.	293	142	209
Took off in crop per acre.....	114	47	60
Gained or lost on Plot A per acre in 1890.....	+179	+95	+149
Put on Plot B in hog manure per acre in 1890..	409	569	72
Took off in crop per acre	120	50	64
Gained or lost on Plot B per acre in 1890.....	+289	+519	+8

	Nitrogen.	Phosphoric acid.	Potash.
Put on Plot C in mixed chemicals per acre in 1890	172	162	69
Took off in crop per acre	103	43	55
Gained or lost on Plot C per acre in 1890	+69	+119	+14
Took off in crop from Plot D which received no fertilizer in 1890	66	27	37
Lost by the soil on Plot D per acre in 1890	−66	−27	−37

If from the quantities of these ingredients added to the plots during the three years in the manure, is deducted the quantities of each ingredient taken from the land in the same time by the crops, the remainder shows how much has been added to (+) or taken from (−) the original capital of the soil by the three years' cropping, leaving out of any account at present losses by drainage or liberation of nitrogen from the soil.

Table I expresses the result in pounds per acre.

TABLE I.—ENRICHMENT (+) OR IMPOVERISHMENT (−) OF SOIL BY THREE YEARS' CROPPING.

	Nitrogen.	Phosphoric acid.	Potash.
Plot A	+113.5	+241.3	+205.9
Plot B	+223.5	+665.3	+ 64.9
Plot C	+ 3.5	+265.3	+ 70.9
Plot D	−131.5	+119.3	+ 19.9

In 1891 practically the same quantities of fertilizers were applied to each plot as in 1890.

Plot A received 20,453 pounds or 3.1 cords of cow manure, equal to 10.3 cords per acre.

Plot B received 21,721 pounds or 4.1 cords of hog manure, equal to 13.6 cords per acre.

Plot C received precisely the same chemicals as in 1890, and Plot D received nothing.

The manure was hauled and spread on April 1st and 3d. The land was plowed about the first of May, and on the 16th of May the fertilizer was sown on Plot C, and all four plots were harrowed and planted.

Planting.

With an Aspinwall planter, White Edge Dent—a variety of maize which has been raised in this farm for many years,— was put in on all four plots alike, in rows four feet apart. The stalks stood on the average 12 inches apart in the row.

Cultivation.

The crop came up well and made good growth through the season. It was cultivated with the horse cultivator three times and the weeds in the rows hoed out. Plots A and B did not differ in appearance through the season. Plot C was at first behind those above named in development, but by the end of the season the difference was not very noticeable. The crop on D was spindling and poor.

The season was very favorable for ripening corn and there was no soft corn in the field at harvest. All of it was sound though on Plot D there were many very small ears or "nubbins."

Cutting and Harvest.

On October 4th the corn was fully ripe and there had been no frost.

There were nine rows in each strip. The central row of each was cut for the laboratory sample and stacked by itself. The whole crop was cut and separately stacked on the same day.

On October 26th, the crop on each plot was weighed and husked and samples were taken to the laboratory and immediately prepared for analysis.

Gross Yield of the Plots.

Table II presents the gross yield of field-cured kernels, cobs and stover on the several plots.

Inasmuch as the kernels were air-dried on the cob the weight of the latter in the field-cured condition could not be ascertained. The weight therefore of the kernels in the table is slightly higher and that of the cobs correspondingly lower than it should be. But the error is insignificant.

The gross yield of kernels and of total crop on plots A and B which received a heavy dressing of manure, is practically the same; the difference being less than three per cent. The Stover on these plots differs by about six per cent. being largest on plot A where cow manure was used.

Plot C, which had received fertilizer chemicals, gave less gross yield than Plot A by somewhat more than eight per cent.

Plot D, which for two years has had no fertilizer of any kind, produced a crop weighing about sixty-two per cent. of the weight of the crop harvested from the plots which had been heavily manured for the last two years.

TABLE II.—GROSS YIELD OF THE PLOTS IN POUNDS PER ACRE.

	Plot A Cow manure.	Plot B Hog manure.	Plot C Chemicals.	Plot D No fertilizer.
Kernels	6003.8	6132.8	5688.0†	3154.6
Cobs*	697.5	717.5	665.7	431.3
Stover	6720.0	6300.0	5969.9	4710.0
	13422.3	13150.3	12323.6	8295.9

DRY SUBSTANCE OF THE CROPS IN POUNDS PER ACRE.

Since the field-cured crops contained large and varying quantities of water a strict comparison of yields can only be made on the dry substance of the crops. This comparison is as follows:

TABLE III.—DRY MATTER OF THE CROPS, POUNDS PER ACRE.

	In kernels.	In cobs.	In stover.	Total.
Plot A, cow manure	4296.3	623.8	3255.8	8175.9
Plot B, hog manure	3723.3	640.7	3235.0	7599.0
Plot C, fertilizer chemicals	2897.0†	594.5	3216.6	6708.1
Plot D, no fertilizer	2515.8	385.2	2490.2	5391.2

The total dry matter is largest on Plot A, which had been heavily dressed with cow manure for two years. The dry matter on plot B, which had a heavy dressing of hog manure for two years was a little more than nine-tenths as large, the yield of plot C,† which had received commercial fertilizers was a little more than eight-tenths as large, while that of plot D that had received no fertilizer for two years was only two-thirds as large as that of the largest yield, that is of plot A.

The yield of dry stover was practically the same on plots A, B and C. The weight of stover on plot D was a little more than three-quarters that of the others.

The greatest differences between the plots is in the yield of dry kernels. Plots B, C and D yielded respectively 86.6, 67.4, and 58.5 per cent. of the yield from plot A.

YIELD OF EACH FOOD INGREDIENT, IN POUNDS PER ACRE.

From the analyses which are given later on and from the gross weights of crops, has been calculated Table IV, which shows how many pounds of each food ingredient was harvested in the kernels, the cobs, and the stover separately and how much in all together. The cobs were not analyzed, but as their total weight was comparatively small and as their composition is not likely to vary widely, the average composition of cobs, as determined in other analyses, was applied for the calculation.

* Air dry. † See foot note on page 145.

TABLE IV.—YIELD OF EACH FOOD INGREDIENT IN POUNDS PER ACRE.

	Plot A.				Plot B.				Plot C.				Plot D.			
	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.
Water	1707.5	74.7	3464.2	5246.4	2409.6	76.8	3065.0	5551.4	2791.0	71.2	2753.3	*5615.5	638.8	46.1	2219.8	2904.7
Ash	60.0	9.8	194.8	264.6	52.8	10.0	184.3	247.1	37.0	9.4	164.2	210.6	32.8	6.0	126.2	165.0
Albuminoids	431.1	16.7	162.6	610.4	375.3	17.2	186.3	578.8	257.7	16.0	157.6	431.3	199.7	10.3	115.9	325.9
Fiber	49.3	210.3	1007.4	1267.0	37.4	215.9	981.0	1234.3	33.0	200.4	1005.3	1238.7	30.9	129.8	776.7	937.4
Nitrogen-free extract	3507.4	383.5	1847.3	5738.2	3043.7	393.9	1831.7	5269.3	2403.3	365.4	1848.9	4617.6	2108.9	236.8	1437.5	3783.2
Fat	248.5	3.5	43.7	295.7	214.1	3.7	51.7	269.5	166.0	3.3	40.6	209.9	143.5	2.3	33.9	179.7
	6003·8	698.5	6720.0	13422.3	6132.9	717.5	6300.0	13150.4	5688.0	665.7	5969.9	12323.6	3154.6	431.3	4710.0	8295.9

* See foot note on page 145.

The production of each food ingredient was greatest on Plot A, least on Plot D.

There was more water in the harvested crop on Plot C than in that of any other plot.*

While the albuminoids make up 7.47 and 7.61 per cent. respectively of the whole dry matter of the crops on Plots A and B they make only 6.05 per cent. of the crop on Plot D.

The crops on A and B are therefore richer in albuminoids, as well as larger than on the other two plots.

Differences in Chemical Composition of Crop caused by Differences in Fertilization.

Table V gives the analyses of the kernels and stover from the four plots both in the field-cured and water-free condition. The latter best serves for comparison.

Fat and Fiber.—There are no striking differences in the per cent. of these ingredients in the crops from the different plots.

Ash.—The per cent. of ash in the kernels from the several plots is practically the same; in the stover it is noticeably lower on Plots C and D.

Nitrogen-free Extract.—(Starch, Sugar Gum),—is one per cent. higher in the kernels from Plot C and two per cent. higher in those from Plot D, than in kernels from Plots A and B.

Table V.—Analyses of Field-cured Maize Kernels and Stover from Plots A, B, C, D.

Plot.	Analyses of Field-cured Maize.						Analyses.		Calculated Water-free.		
	Water.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract (starch, gum, etc.)	Fat.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract (starch, gum, etc.)	Fat.
Kernels.											
A	28.44	1.00	7.18	.82	58.42	4.14	1.42	10.05	1.15	81.60	5.78
B	39.29	.86	6.12	.61	49.63	3.49	1.42	9.98	1.02	81.81	5.77
C	49.07*	.65	4.53	.58	42.25	2.92	1.26	8.89	1.15	82.97	5.73
D	20.25	1.04	6.33	.98	66.85	4.55	1.30	7.95	1.23	83.83	5.69
Stover.											
A	51.55	2.85	2.42	15.04	27.49	.65	5.88	5.02	30.97	56.76	1.37
B	48.65	2.93	2.96	15.57	29.07	.82	5.70	5.76	30.32	56.63	1.59
C	46.12	2.75	2.64	16.84	30.97	.68	5.10	4.90	31.26	57.47	1.27
D	47.13	2.68	2.46	16.49	30.52	.72	5.07	4.66	31.13	57.77	1.37

* The per cent. of water in the kernels from Plot C is so much higher than that in the kernels of either of the other plots or than has ever been found in field-cured maize from this locality that an error in weighing or recording the weight of the subsample of kernels is strongly suspected. This cannot now be detected or remedied. Therefore there is reason to doubt in case of the kernels from Plot C, the correctness of the figures for gross yield, for dry matter, water, and all the other ingredients and the analysis in the field-cured condition. This affects only the kernels on Plot C. The water-free analysis is not affected.

Most interesting are the differences in the per cent. of protein in the kernels, that portion of the plant which is regarded as most constant in composition.

The dry matter of the kernels from Plots A and B, the heavily manured plots, contained in round numbers one per cent. more protein than the kernels from Plot C* which received commercial fertilizers and two per cent. more than those of Plot D which had no fertilizer.

On plots which received an excess or an abundance of available plant food, the kernels in the crop were decidedly richer in albuminoids and less starchy than on plots which were relatively deficient in plant food.

Quantities of Nitrogen, Phosphoric Acid and Potash applied in the Manure or Fertilizer and Removed by the Crop.

The manure used, which was made from the same kind of feed and of animals as in 1890, was not analyzed again in 1891 but was assumed to have the same composition as in the previous year.

In Table VI are given, first, the total quantities of nitrogen, phosphoric acid and potash which have been applied to the land in the years 1888, 1889 and 1890 in excess of the quantities removed by the crops of those years, second, the quantities applied in 1891, third, the quantities removed by the maize crop of 1891 and fourth, the quantities of these ingredients added in four years in excess of what was removed by the four crops, marked [+], or the quantities of each removed by the crops in excess of what was supplied in fertilizers, marked [−].

The larger quantity of phosphoric acid and smaller quantity of potash in excess on Plot B as compared with A is explained by differences in the feed of the cattle which made the manure used. The cows ate large quantities of hay and stover, relatively rich in potash while the hogs had phosphates in the bones which came in garbage, but potash in the food was relatively small in quantity and it may be that the slightly smaller yield in 1891 of Plot B was caused by a relative deficiency of potash.

So heavy an application as 4.1 cords per acre of this hog manure while supplying nitrogen and phosphoric acid in very great excess of the quantity which the crop removes supplies only a small excess of potash, less than eight pounds.

* See foot note, page 145.

TABLE VI.—ENRICHMENT OR IMPOVERISHMENT OF SOIL BY FOUR YEARS MANURING AND CROPPING.

	Cow Manure. Plot A.			Hog Manure. Plot B.			Fertilizer Chemicals. Plot C.			No Fertilizer. Plot D.		
	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.
After three years' cropping.	+113.5	+241.3	+205.9	+223.5	+665.0	+64.9	3.5	+265.3	+70.9	−131.5	+119.3	+19.9
Applied in 1891.....	286.3	136.4	204.5	419.9	586.5	72.4	172.0	162.0	69.0	00.0	00.0	00.0
Taken off in Crop of 1891.	97.7	37.5	79.9	92.7	31.6	65.0	69.3	23.5	47.7	52 1	22.2	30.7
Leaving in excess (+) or deficiency (−) after four years' cropping.....	+302.1	+340.2	+330.5	+550.7	+1219.9	+72.3	+106.2	+403.8	+92.2	−183.6	+97.1	−10.8

The relative proportions of phosphoric acid, potash and nitrogen in the average maize crop and in the cow manure and hog manure made on this farm are as follows:

	Phosphoric acid.	Potash.	Nitrogen.
Average maize crop	1	1.6	2.4
Cow manure	1	1.9	2.7
Hog manure	1	.12	.72

That is, for every pound of phosphoric acid removed by the crops, 1.6 pounds of potash and 2.4 pounds of nitrogen are also taken. With every pound of phosphoric acid applied in cow manure, 1.9 pounds of potash and 2.7 pounds of nitrogen are applied; the ratio being quite nearly the same as in the crop.

But if enough hog manure is applied to cover the nitrogen which is to be removed in the crop, there will also be applied about three times as much phosphoric acid but only one-third as much potash as the following crop will remove.

Of course in crop rotation as usually practiced, the crop residues and unused manure remaining in the soil as well as the natural capacity of the soil itself, are taken account of in manuring for the next crop.

Yields of "Shelled Corn," and Percentage Composition of Dry Matter for Four Years.

Table VII shows the largest crops of dry matter, reckoned to the acre, which were harvested in 1888 and 1889 and their percentage composition, together with all crops from drills in 1890 and from Plots A, B, C, D in 1891 calculated to an acre. The rows were four feet apart in all four years.

The plots marked A were on cow manure, B were on hog manure, C on commercial fertilizers, and D had no fertilizer in the years 1890 and 1891.

As it is customary to judge of a maize crop by the yield of "shelled corn" in bushels, the yields have also been calculated in this way with the results given in the fourth column of the table. In this calculation twenty per cent. has been added to the weight of water-free kernels for the water in corn cured enough to shell and 50 pounds has been assumed as the weight of such shelled corn per bushel.

TABLE VII.—YIELD OF DRY MATTER AND "SHELLED CORN" PER ACRE FOR FOUR YEARS AND PERCENTAGE OF DRY MATTER.

	Year.	Distance of Planting.	Yield of Dry Matter per Acre.	Bushels of Sound Shelled Corn.	Percentage Composition of Dry Matter				
					Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
Fertilized alike	1888	Stalks 12 inches apart,	7350	75	3.3	7.8	19.4	66.1	3.4
	1888	" 6 " "	7980						
	1889	" 12 " "	6144	60	3.5	6.1	21.7	69.7	3.0
	1889	" 6 " "	6352						
On Cow Manure	1890A	" 10 " "	9014	91	4.0	7.9	19.8	65.7	2.6
On Hog Manure	1890B	" 10 " "	9436	97	4.2	8.0	19.6	65.5	2.7
On Fertilizer Chemicals	1890C	" 10 " "	8070	87	3.9	8.0	21.2	64.4	2.5
No Manure or Fertilizer	1890D	" 10 " "	6626	51	3.8	6.2	20.7	66.7	2.6
On Cow Manure	1891A	" 12 " "	8176	103	3.2	7.5	15.5	70.2	3.6
On Hog Manure	1891B	" 12 " "	7599	89	3.3	7.6	16.2	69.3	3.6
On Fertilizer Chemicals	1891C	" 12 " "	6708	70	3.2	6.4	18.5	68.8	3.1
No Manure or Fertilizer	1891D	" 12 " "	5391	60	3.1	6.0	17.4	70.2	3.3

FURTHER RESULTS FROM THE APPLICATION OF FUNGICIDES TO PREVENT THE "SPOT" OF QUINCE (*Entomosporium maculatum.*)

By Dr. Roland Thaxter.

In the last report of the Station (1890) photo-reproductions were given showing the beneficial results of treatment with Bordeaux mixture for the leaf-spot of quince in the orchard of Mr. Geo. F. Platt at Milford, as compared with portions of the same orchard which received no treatment, the rows in the one case having retained their foliage intact till the last of October, while the untreated rows beside them lost their leaves by the end of summer. Owing to the injury done by the fungus in previous years no fruit set in 1890, even on the treated rows, a natural result of successive defoliation, and it was suggested in the report just referred to that a second season's treatment would have an additional interest in connection with the comparative set of fruit on the rows treated and untreated during the previous year. That the effect was strikingly in favor of the treatment, may be seen by reference to the photo-reproduction of single treated and untreated rows reproduced from photographs taken about September 20th, as well as by the figures which will be given presently.

At the time of blossoming, in May of the present year, the treated rows were conspicuous from a distance by the much greater body of bloom upon them, and it may be mentioned that the two rows which had received Bordeaux mixture showed a decided superiority in this respect over those treated with carbonate of copper.

The first treatment of the season was given just as the first blossom buds were opening, and in all the applications the two Bordeaux-mixture rows were sprayed with the same strength of the mixture which was employed during the season of 1890 (6 lbs. sulphate of copper, 4 lbs. of lime, to 25 gallons of water). On the two remaining rows that were treated, a precipitated carbonate of copper was used in place of the ammoniacal solution employed in 1890, about three pounds of sulphate of copper being precipitated

from concentrated solution with carbonate of soda, and then diluted to twenty-five gallons with water.

The first application was made May 11, the second May 28, and the third *and last* June 22. Owing to the unusually dry summer a fourth application was unnecessary, the Bordeaux mixture adhering so firmly that it was conspicuous on the leaves late in September.

The rows treated with Bordeaux mixture set an abundant yield of fruit, in most cases as much as the tree could properly mature, while the other two treated rows set a much smaller amount. The "set" of the untreated rows was very small, and at the time of harvesting the relative yield of *marketable* fruit was as follows:

	Marketable fruit.
Two rows sprayed with Bordeaux mixture in 1890–91.....	71½ baskets.
" " " " ammoniacal carbonate of copper in 1890, and with precipitated carbonate of copper in 1891.....	7 "
Five rows untreated in 1890–91.....	1 "

The superiority of the fruit from the rows sprayed with Bordeaux mixture as compared with that from the other treated rows in regard to the *quality*, was quite remarkable. While the yield from the carbonate of copper rows was very fair as regards quantity, the fruit was so badly injured by the spot and more especially by being "wormy," that only the very small quantity of fruit above stated was found to be marketable. The apparent effectiveness of the Bordeaux mixture in keeping off the quince "maggot" suggests the advisability of using an insecticide with the fungicide in the first two treatments as is often done in spraying for the codlin moth and apple scab. If Paris green is used it should be mixed to a smooth paste with a little water, and then stirred into the Bordeaux mixture in the proportion of one pound of Paris green to 100 gallons of mixture.

The application of the fungicide in the present case was made much more effective than in the previous year, and a perfectly even distribution of the material ensured by means of a plunger, which was worked in the barrel by the person who pumped. This consisted of a broom-stick with a short piece of board screwed on the end and was worked through a small hole bored in the top of the barrel. Such a contrivance, the details of which need not be dwelt upon, gives the most satisfactory results for rapid and complete stirring, and is indispensable for good work.

It was found that a second or third stream turned into the barrel was either utterly ineffectual in practice, or interfered too seriously with the working of the nozzles if it was made large enough to do its work with any thoroughness.

The cash account with the two rows treated with Bordeaux mixture is about as follows :

Dr.	
To 3 men and team 3 hours	$1.80
To 36 lbs. sulphate of copper at 6c.	2.16
To 24 lbs. lime at 1 c.	.24
	$4.20
Cr.	
To 71½ baskets of first-class fruit at .75	$53.62
Balance above expenses	$49.42

Comparing the yield from the untreated rows and estimating it at ½ basket per row, which is more than was actually obtained, the net income from a single treated row was one hundred times as great as from an untreated row.

Quince Orchard showing result of Spraying with Bordeaux Mixture, 1891.

Adiacent row showing result of no treatment.

POTATO SCAB.

By Dr. Roland Thaxter.

Since the publication of the report of the Station for 1890, in which the cause of the above disease was described in some detail and referred to the action of a peculiar fungus as yet unnamed, experiments on the subject have been continued at the Station and elsewhere, which fully corroborate the conclusions reached in regard to the causation of the disease. Cultures and infections under test conditions, similar to those described in the report referred to, were repeated in the green-house with similar results and demonstrated beyond question that the fungus and the disease are directly connected as cause and effect. Observations in the field in Connecticut as well as in other New England States, have also satisfied the writer of the correctness of this view, the fungus being easily demonstrated in every case examined, and visible to the naked eye in all freshly dug tubers affected by the disease in question.

It should be remarked that no condition of the disease, whether deep-seated or superficial, was found without this accompanying growth, and the season's observations in this respect have led the writer to believe that the supposed types of the disease previously referred to as "deep" and "surface" scab are really variations, merely, in the action of the same agent, which might be readily attributable to various physiological or other causes. This view is also supported by further observations which will be referred to presently; but it is still possible that the writer has never encountered the surface form in nature and that the apparently invariable occurrence of the fungus may be thus explained.

Through the kindness of Prof. Arthur the writer received a small lot of tubers from La Fayette, Ind., affected by the same form of the disease recently studied by Prof. Bolley and pronounced by him to be of bacterial origin. Unfortunately plate cultures were not made from these specimens; but all were planted in clean ground in which undiseased tubers planted at the same time yielded a practically clean crop. The La Fayette tubers, however, yielded from the eleven hills planted, 50 per

cent. of scabbed tubers, on every diseased spot of which the fungus was apparent to the naked eye.

Prof. Arthur also writes me that he has isolated the scab fungus at La Fayette from tubers grown in that vicinity, and Prof. Bolley himself has found no other cause associated with the disease as it occurs in North Dakota, his present station. In a recent bulletin upon the subject (Bulletin No. 4, N. Dakota Experiment Station, Dec., 1891), Prof. Bolley remarks that "The first cause of deep scab as studied here is found to be a plant organism of very minute character which attacks the surface of young growing tubers, eroding, irritating and blackening the adjacent tissues, and is identical with that associated with the disease in the East (Thaxter l. c.)," also that "Pure masses of the scab plant grown upon nutrient gelatine as seen in Fig. 1, free from all other germs, when transferred to the surface of healthy growing potato tubers, will invariably produce the disease at the point of application."

The writer's results are thus strikingly confirmed by observations made in a widely different locality as well as by the additional experiments, already referred to, which have been made at this Station, and there seems little doubt as to the true origin of the disease, as it occurs in this vicinity.

Prof. Humphrey informs me that the supposed bacterium of scab was isolated by Prof. Bolley from material received from Amherst, Mass., and pronounced by the former observer to be identical with the La Fayette form. If two distinct diseases really exist, therefore, they should be more or less widely distributed in New England as well as in the Western States. As already mentioned, however, the writer is inclined to believe that there is no essential difference between the two as to cause at least. But since Prof. Bolley is in a better position to judge concerning this matter from his more extended acquaintance with the La Fayette form, I take the liberty of quoting from his bulletin already referred to, merely remarking that I am inclined to agree with his suggestion that the so-called bacterium of scab is merely an accompaniment and not a cause of the disease, and probably only partially (if it is at all) parasitic in a state of nature.

"As to the question whether two distinct diseases exist, I may say that I am even yet much in doubt. This would at first glance seem to imply that I doubt the accuracy of my last year's infection tests. This is, however, in no wise necessarily so, as various

other circumstances are involved which render such an assumption on my part as yet comparatively groundless. Certainly, in common with those conversant with the details of such work, I recognize that there are many possibilities of error; but that work was too carefully done to admit of any change in the assertion made in the report of the same (Agricultural Science, loc. cit.) other than in so far as they assume only one form of the disease, a point which with me must remain in doubt until I shall have been able to do work under conditions similar to those under which the work was then carried out. The organism with which I then worked, a true bacterium, was undoubtedly very different from that pointed out by Dr. Thaxter, as the originator of "*deep scab*," the one which upon coming to Dakota I was immediately and readily able to recognize as the active agent in the disease here. Furthermore, in so far as cultural and infection tests have been conducted this year, affirmative results have been attained only with the latter form, the bacterium not being found. I have, however, to that end, to date, used only the disease as found here, a form very much more pronounced than that studied last year, possessing some characteristics of action not then noticed. How many of these were present but not then noticed, and how much they are due to soil differences, I cannot say. Certain it is that it is hard to draw the line between a *surface* and a *deep* form of the disease from a consideration only of gross characters, unless it be in the point of a pink coloration of the surrounding living tissues not then noticed.

That, in the Indiana work, I many times under apparent exclusive infection conditions, induced potato scabs, recognized as such by all who saw them, there is no question. Considering then for the time that the disease as generally understood has but one origin, there are two possible ways for accounting for those results: *First*—Error in formation of the infection material so that other germs than the bacterium were present (possible but not probable). *Second*—That the bacterium used (which was undoubtedly parasitic in the potato plant) might under the conditions of the inoculations produce the scabbing which in nature would not occur. This I deem very probable from the then determined capabilities of the bacterium to penetrate living tissues of the potato plant even to parts of young growing stems. The question is yet an open one. I can only regret that my authentic material was unavoidably lost and await opportunity to give it

further test. I may say, however, that the parasite studied this year acts much more rapidly in artificial infection than did the bacterium, and there is little question that it is the originator of the chief amount of damage done by potato scab." (Bolley, l. c.)

The experiments made at this Station during the present year consisted in a repetition of the artificial infection of growing tubers in the green-house, with pure scab fungus grown on potato agar and transferred to definite areas in the form of letters, etc., as described in my former report. But since they merely confirm the conclusions already stated in the report just mentioned, it is superfluous to describe them in detail. It may, however, be mentioned that in connection with these inoculations an attempt was made to produce an effect upon growing tubers by means of the fungus spoken of in my previous report (p. 17 note) and doubtfully referred to *Oospora perpusilla* by Prof. Saccardo. Pure cultures of this fungus were obtained from horse dung on which it always appears as a whitish coating, but when transferred to the potato tubers no effect whatever was produced.

Two small field experiments were also tried upon the Station grounds. The first of these was intended to test the effect, if any, of sulphur and of muriate of potash used as a fertilizer in the hills, upon the amount of scab produced in tubers grown on land known to be infected. The experiment was without result, no difference being found between the hills thus treated and the alternate hills untreated, the tubers being very generally scabbed in all cases.

A second experiment was tried on a piece of new land, also on the Station grounds, the sod of which had not been turned for a period of years. On this land 178 hills were planted as follows:

Set a.—28 hills; planted with scabbed seed known to be attacked by the scab fungus, every second hill unfertilized, the rest fertilized with mixed fertilizer.

Set b.—28 hills, planted with clean Beauty of Hebron seed. Every second hill unfertilized, the rest fertilized with manure from horse fed on hay and oats.

Set c.—28 hills, planted as in *set b*, but every second hill fertilized with manure from horse fed on oats in which pure cultures of the scab fungus had been mixed.

Set d.—14 hills, planted as in *b* with addition of a trowel full of oxide of iron in the alternate hills, every second hill fertilized with mixed fertilizer.

Set e.—14 hills, planted as in *b*, the alternate hills containing broken plaster and cement, the rest mixed fertilizer.

Set f.—22 hills, every other row planted with scabbed seed from La Fayette (unfertilized), the rest as in *Set b*, unfertilized.

Set g.—28 hills, planted as in *b*, the alternate rows fertilized with wood ashes, the rest with commercial fertilizer.

The potatoes were dug July 28, with the following results:

Set a.—66½	per cent.	scabbed	badly in all hills.
Set b.—5	"	"	in hills containing manure.
9	"	"	" " commercial fertilizer.
Set c.—50	"	"	" " manure.
3½	"	"	" " commercial fertilizer.
Set d.—8	"	"	" treated with oxide of iron.
2	"	"	in alternate hills.
Set e.—60	"	"	in hills containing plaster, etc.
6	"	"	in alternate hills.
Set f.—50	"	"	in hills containing La Fayette seed.
4	"	"	in alternate hills.
Set g.—7½	"	"	in hills containing wood ashes.
12½	"	"	in alternate hills.

As far as so small an experiment is of value the results seem to show that in clean land in which about six per cent. only of the crop of potatoes would be normally scabbed, (1) scabbed seed very greatly increases the number of diseased tubers produced, (2) that barn-yard manure which has not been contaminated by the scab fungus, either by food ingested or otherwise, *may* not materially increase the amount of scab, (3) that oxide of iron in amount sufficient to color new tubers red exerts no appreciable influence on the amount or virulence of scab, (4) that plaster and cement, for some reason not apparent, exercises a very decided influence, especially upon the virulence of the disease, which was worse in these hills than in any others, (5) that wood ash has no apparent connection, as has been suggested, with the presence of the disease.

Although the hills fertilized with barn-yard manure from a horse fed with pure culture of the scab fungus, show a decided increase in the amount of scab, the experiment can hardly be considered a fair one, as the cultures in question consisted almost wholly of the vegetative mycelium of the fungus, so that comparatively few spores were ingested, and the purely vegetative hyphæ may have been killed in the digestive tract, such spores as were present alone surviving, and perhaps multiplying only to a limited extent in the fæces after evacuation. The reverse would be true where scabbed potatoes, on which the spore formation is always very abundant, were fed to stock, and the writer is con-

vinced that the practice of feeding diseased tubers in this way is one of the most important means by which the disease is spread on farms. In view of the well-known fact that great numbers of fungus spores can and do pass through the digestive tract without injury, and that the scab fungus is known to grow luxuriantly in decoctions of horse or cow dung, it is not unreasonable to assume that its spores, passing through the digestive tracts of stock fed with diseased potatoes, continue their development in the manure after evacuation, and thus afford the means of wide-spread infection on land fertilized with such material.

The condition of the hills treated with plaster and cement was very striking; the scabs upon the tubers being unusually deep and widespread and the grey appearance produced by the fungus very conspicuous. The reason for the apparent stimulus which these substances seem to exert on the growth and spread of the fungus is not easily explained, and further experiments should be made to ascertain whether or not the results obtained were accidental.

The theory entertained by many persons in the State, that scab originated with the use of wood ashes as a fertilizer, is certainly in no way supported by the results obtained, and it is moreover quite improbable that so thoroughly sterilized a substance should be a medium of infection.

In regard to the question of prevention by treatment little can be said. Prof. Bolley in the Bulletin referred to, gives the results which he obtained by treating the seed potatoes in various ways in order to kill the fungus upon seed tubers before planting: but the use of clean seed would seem to be a simpler and more effectual means of avoiding infection of this nature. The application of any substance to the vines is manifestly absurd in view of the nature and action of the disease, and it seems extremely doubtful whether any advantage would be gained by treating the seed and adjacent earth with Bordeaux mixture (as claimed in a recent bulletin of the Rhode Island Experiment Station) or with any other substance.

Certain preventative measures may, however, be taken with great advantage.

(1.) The seed must be free from any scabs.

(2.) Land which has produced scabbed crops in previous years either of potatoes or of beets or has been fertilized with manure from scab-fed stock must not be planted to potatoes.

(3.) Scab potatoes should never be fed to stock under any circumstances, unless they have been thoroughly cooked, even if the land on which the manure is to be used is not to be cropped with potatoes at once.

(4.) In general any fertilizer is to be preferred to barn-yard manure for potatoes, whether the stock has been fed with diseased potatoes or not.

(5.) If it is suspected that a crop is scabbed *it is of great importance to dig the potatoes as soon as possible* after they are mature, since the scab spots increase in size and deepen as long as they are left in the ground and what is at first a comparatively slight surface injury may be sufficiently extended to render tubers worthless which would otherwise have been marketable.

In regard to the botanical relations of the fungus producing scab, it has already been stated that the form appears to be undescribed, and since a definite designation seems desirable for the agent of so important a disease the following diagnosis may be given.

Oospora scabies, nov. sp.

Vegetative hyphæ brownish .06–1 μ in diameter, curving irregularly, septate or pseudoseptate, branching. Aërial hyphæ at first white, then grey, evanescent, breaking up into bacteria-like segments after having produced single terminal spiral spores (?) by the coiling of their free extremities. Forming a firm lichenoid pellicle on nutrient jelly and usually producing a blackish-brown discoloration of the substratum on which it grows, causing the disease known as "scab" on potato tubers, and a similar disease of beet roots (sec. Bolley).

The fungus is referred to Oospora merely for the reason that it appears more nearly allied to certain forms included in this genus by Saccardo, than any others known to the writer. There seems to be, however, at least one, perhaps several saprophytic forms, having the same morphological characters, which may prove constant enough to warrant a new generic designation. The white "efflorescence" which appears on horse dung soon after it is placed in a moist chamber, is almost identical with the scab fungus, and similar forms are constantly met with especially in transfers to plate-cultures from all sorts of substances. It is needless to remark that the genus Oospora, as given by Saccardo, has no scientific value, and the reference of a form to this genus is merely, as

in the present case, a confession of ignorance concerning its true position.

It is to be hoped that observers in Europe may be induced to examine the disease as it occurs there, in the light of the writer's observations, and substantiate or disprove the conclusions reached as far as concerns the European form of the disease. The fungus is unusually easy to isolate by plate-cultures of potato agar or gelatine, on account of its blackening effect upon the substratum, so that its presence or absence even in old scabs is readily ascertained. One precaution only is necessary, namely, that the material for culture be taken from near the surface of the tuber, or at least not from the deeper tissues which may be invaded only by bacteria that have followed the attack of the fungus, and extended its injury.

THE CONNECTICUT SPECIES OF GYMNOSPORANGIUM (CEDAR APPLES).

By Dr. Roland Thaxter.

So much has been written in popular and scientific literature concerning the so-called Cedar Apples and their connection with the production of certain rusts on fruit trees and elsewhere, that it is unnecessary here to give more than a general statement of the facts which should by this time be familiar to agriculturalists generally or at least to fruit growers who are directly interested in the matter. The general facts referred to are as follows. Towards the end of spring, usually in early May, and during rainy weather, the fungus which produces the well-known distortions (cedar apples) just mentioned, protrudes from them in the form of orange-colored gelatinous masses, the orange color being chiefly due to vast numbers of fungus spores formed on the surface of these masses, and known as *teleutospores*. These teleutospores germinate rapidly, without becoming detached from the swollen masses, and give rise each to a number, sometimes as many as a dozen, small secondary spores which are discharged into the air from the sides of short threads protruding from them at various points. These secondary spores (*sporidia*) falling into the air are blown to apple or quince trees or some other plant of the same family, and adhering to the surface of the tender leaves or shoots germinate in their turn, and entering the plant tissues produce in and upon them the second or rust condition of the fungus, known as the *Roestelia* stage. The rust first shows itself as an orange or yellow spot on the upper side of a leaf for instance, in which cavities are formed producing certain bodies (*spermatia*) of unknown function, while subsequently after a period of time varying in different species from ten days to three or even four months the Roestelia appears in the form of tooth-like projections from the under side of the same spot. These projections contain great quantities of spores which are discharged into the air, and blowing back to the cedars and germinating upon them enter their tissues and give rise to new cedar apples which again reproduce the rust and so on.

The object of the present paper is to call attention to experiments which have been carried on at this Station in regard to the relations of the different species of cedar apples to the various forms of rust or Roestelia which they produce, and more especially to the development of the so-called "bird's nest" Gymnosporangium, the characteristic distortions of which are so familiar as to need no further description. Although so common a species, the experiments and observations of the writer have demonstrated that it has been hitherto undescribed, owing to various confusions which need not here be dwelt upon, and the appropriate name *nidus-avis* (bird's nest) is here proposed to distinguish this characteristic and strictly American form. The interest in the subjoined account is therefore rather scientific than economic, except in so far as it enforces the already well-known fact that to avoid certain rusts which are often serious on apple, quince or pear trees as well as on hawthorn used for ornamental or other purposes, and several related plants, it is necessary to cut down adjacent cedars as far as is practicable; for although it has been shown that infection from cedars may take place at a distance of eight miles, the virulence of the disease is of course proportionate to the proximity of the cedars.

We have in Connecticut, so far as is now known, seven distinct species of Gymnosporangium; two upon the white or swamp cedar (*Cupressus thyoides*), neither of which are economically important, one peculiar to the common juniper (*Juniperus communis*), three upon the red cedar (*J. Virginiana*), and one occurring on both the last named plants; the last five species all possessing more or less economic interest, from the rusts which they are likely to produce. The writer has continued experiments on all these species for the past five years, and has succeeded by artificial cultures under test conditions in connecting all but one of them (*Gymnosporangium Ellisii*) with its proper rust, making at the same time a critical study and comparison of the different forms and stages. In a paper on the subject published in the Botanical Gazette (Vol. xiv, No. 7) attention was called (p. 169 and 172, note) to the fact that the so-called bird's nest Gymnosporangium of the red cedar, which had hitherto been confused with another American (*G. clavipes*) as well as with a European species (*G. conicum*), was shown by cultures made at this Station and at Cambridge as well as by observations made in the vicinity of New Haven, to be a distinct and peculiarly American form as above stated.

In regard to the remaining species of Gymnosporangium it may be mentioned in passing that the experiments performed by the writer before he became connected with this Station have been repeated here in the case of *G. macropus*, *G. globosum*, *G. biseptatum*, and *G. clavariaeforme*, the failure of cultures with *G. Ellisii* on the two occasions when they were attempted, having been directly traceable to the use of teleutospores which were not in good condition for cultures, the species not being readily obtainable in a fresh state. In the case of *G. macropus*, *G. clavariaeforme* and *G. biseptatum* results were obtained identical with those previously published by the writer, while in the case of *G. globosum* certain additional facts were ascertained; namely that perhaps the most common orange rust of apples in this state is undoubtedly caused by this species. This rust, which has been referred to in previous papers as "*lacerata z*," was induced by inoculation with sporidia from *G. globosum* on three seedling russets, the inoculation being made in the greenhouse by forcing the cedar apple as well as its host so early in the spring that all possibility of accidental mixture was avoided. Spermogonia appeared the first week in April, the infection having been made late in March, and perfect and typical aecidia were developed early in July. In addition to the cultures of *G. globosum* which were made on these apples, two plants of the mountain ash (*Pyrus Americana*) were inoculated with the same Gymnosporangium in April, and having produced luxuriant spermogonia gave abundant and well developed aecidia late in July. It may be mentioned in passing that these aecidia were *not* the *Roestelia cornuta* which occurs on the same host further north, but had all the characters of the Roestelia which follows inoculation by *G. globosum* on other hosts. In addition to the above facts it was ascertained that a rust of quinces and of Keiffer pears both hitherto unrecorded hosts for this species, was referable to the same source. Cultures of *G. globosum* on Hawthorn (*Crataegus crus-galli*) were also repeated and produced abundant and well developed aecidia under equally strict conditions, confirming the writer's previous statements in all respects.

Returning to the "bird's nest" Gymnosporangium, infections with this species have been made by the writer every year since the spring of 1886, in order to determine definitely the true character of the rust which it produced, and the results in all the cultures were identical, as to the mode and rapidity of development

and gross as well as microscopic characters. Until 1889, however, this rust had never been recognized in nature; but as soon as search was made for it in the light of the results artificially obtained, it was found in abundance near the Station and elsewhere in the State growing on Quince, but most luxuriantly on the Service berry (*Amelanchier Canadensis.*) Owing to its rapid development, the Roestelia matures by the first of June, simultaneously with the Roestelia of the juniper Gymnosporangium (*G. clavariæforme*), and since the two rusts inhabit both the above-mentioned host plants, they often occur together side by side on the same leaf, shoot or berry. For this reason although the two are quite distinct in gross appearance when closely examined, as well as in microscopic characters, they have never hitherto been distinguished and will doubtless be frequently met with in herbaria under *Roestelia* "*lacerata*," or the equally erroneous name *R. penicillata.* The general habit of the two is much the same, the *Roestelia nidus-avis* being, however, slightly less lacerate than *R. lacerata* and much darker owing to the rich rust brown color of its spores which contrasts strongly with the much paler dead brown of the spores of *R. lacerata* when seen *en masse.* Microscopically the two are separated at a glance, the spores of *R. nidus-avis* being smooth while those of *R. lacerata* are verruculose.

The *Gymnosporangium nidus-avis* it may be mentioned by no means confines itself to bird's nest distortions, but may occur in isolated areas on the smaller branches on which it produces a slight swelling like *G. clavipes*, or may attack the larger branches and even, not uncommonly, the main trunk of the tree in which its perennial mycelium has survived for years as a result of infection when the tree was very small, causing a conspicuous swelling of a part or the whole of the trunk, the bark of which in the diseased area is usually very rough. That these forms are not due to any species other than the *nidus-avis* has been shown by cultures.

The new species may be characterized as follows:

Gymnosporangium nidus-avis, nov. sp.

Sporiferous masses when young, cushion like, irregularly globose or oval, small and distinct or elongate and confluent according to the habitat; rich red brown; when mature indefinitely expanded by moisture, orange-colored. Teleutospores two-celled, irregular in

shape, broadly ovate to sub-elliptical or fusiform, bluntly rounded or slightly tapering towards the apex, symmetrical or often slightly bent. Average dimensions .055 × .025^{mm}. Promycelia several, not uncommonly proceeding from either extremity. Pedicels when young often more or less inflated below the spore. Mycelium perennial in leaves, branches or trunks of *Juniperus Virginiana* very commonly inducing a "bird's nest" distortion.

Roestelia stage. Spermogonia yellowish orange, preceding the aecidia by about ten days. Aecidia hypophyllous or more commonly on petioles, young shoots and especially on young fruit, densely clustered, brown, at first subulate, then fimbriate; the peridia splitting to the base with its divisions slightly divergent. Peridial cells rather slender; the ridges somewhat prominent, sublabyrinthiform, horizontal or becoming inwardly oblique towards the extremites. Average measurements (towards the apex of the peridia) .07 × .018^{mm}. Aecidiospores smooth, spherical or irregularly oval to oblong, average diameter 25^{mm}.

Mycelium annual in the leaves of *Cydonia* (quince) and in leaves, stems and fruit of *Amelanchier Canadensis* (Service berry) in June.

FUNGUS IN VIOLET ROOTS.

By Dr. Roland Thaxter.

Specimens of diseased violet plants have been received at the Station several times and the present note is designed to call attention to the presence in the roots of such diseased plants of a peculiar fungus, not previously observed in this country, as far as the writer is aware. It is a well known fact that in the Middle and New England states violet growers are often subjected to great loss from the effects of a somewhat obscure affection which stunts or hinders the growth of the violet plants, causing them to turn yellowish and giving them a generally sickly look. This sickly condition may be present in plants grown under glass as well as in open ground, and appears to attack those grown out of doors most severely during continued damp weather. It may or may not be accompanied by the leaf spot fungus (*Phyllosticta violæ*) which in itself is often a very destructive disease, or by certain minute insects resembling the "red spider" of greenhouses, but much smaller and hardly visible to the naked eye, which might be responsible for much of the damage. Nevertheless many plants having the characteristic sickly yellow look of the violet disease have been received and examined, on which no sign of either the fungus or the insect could be found. No apparent cause for the observed condition being discoverable in the portion of the plant above ground, the writer was led to examine the roots and stems with some care and after washing the earth from the former, great numbers of dark spots were observed commonly involving the whole substance of the root for a distance of a few millimeters. Sections of such spots show the tissue more or less blackened and destroyed and lying in the cells, in greater or less numbers, certain peculiar looking squarish brown bodies, sometimes filling the cells completely and looking not unlike some form of smut. These squarish bodies are the result of the breaking up of large cylindrical 2–5 (or more) septate brown spores formed from a rather scanty septate mycelium which apparently causes the death of the root cells at the affected points.

The fungus is undoubtedly the form described by Zopf (Sitz. d. Bot. Ver. d. Prov. Brandenb. June 1876, p. 105) under the name *Thielavia basicola*, figured in Winter's Pilze (Vol. II, p. 44) and also described and figured by Sorokin as *Helminthosporium fragile* (Clasterosporium frag. Sacc.) in Hedwigia (1876, p. 113) where the characteristic breaking up of the spores into squarish segments is well represented. According to Zopf the fungus is the same with the form described by Berkeley & Broome (Ann. and Mag. of Nat. History, Ser. II, Vol. V, No. 465, Pl. 11, fig. 4) as *Torula basicola*, yet for reasons not mentioned all these are kept distinct by Saccardo.

Zopf describes an ascosporic condition on which the genus Thielavia is founded, which has not been observed by the writer except as a parasite on other fungi (species of Isaria), and states that a very serious disease of the roots of Senecio is due to its action.

As concerns the disease of violets, however, it seems doubtful whether the observed injury done by the Thielavia would alone account for the condition of the plants, yet the mere presence of a form supposed to cause serious disease in the roots of other plants, seems of sufficient interest to warrant the present note.

Another disease of violet roots due to nematode worms and common in Connecticut as in other localities, produces great numbers of hard rounded swellings upon the roots, but according to the statements of several violet growers does not appear to do much injury to the plants.

PRELIMINARY REPORT ON THE SO-CALLED "POLE-BURN" OF TOBACCO.

By William C. Sturgis, Ph.D.

Ever since the year 1833 when the tobacco industry of Connecticut was permanently affected by the introduction from Virginia by B. P. Barber of East Windsor of what is now known as the "Barber broad-leaf variety," and the growing of fine, silky tobacco suitable for wrappers, superseded the strong, narrow "Shoestring" tobacco, this important crop has been seriously injured by several diseases, mycological as well as physiological in nature.

The present report has to do with the cause and effects of one of these diseases, familiarly known in this State and in other sections of the country as "pole-burn," "pole-sweat," and "house-burn," names indicative of the burned appearance of the affected leaves.

Origin of "Pole-burn."

Practical experience has shown us the conditions under which this disease makes its appearance. Thus all tobacco-growers know that if the tobacco is cut and hung during warm, damp, and foggy weather it is very susceptible to "pole-burn;" that if a period of such weather ensues a week or ten days after the hanging of the tobacco, even though the conditions under which the tobacco was cut and hung were favorable, the crop is sure to suffer more or less; in brief, that the severity of the disease is intimately connected with atmospheric conditions.

The appearance of tobacco affected with "pole-burn" is too familiar to require any extended description.

As the disease was first brought to the notice of the writer it was seen to be characterized by the appearance on the surface of the leaf, of small blackened areas, giving the leaf the aspect of having been sprinkled with sulphuric acid, or some other corrosive liquid. At first the disease is limited to the neighborhood of the veins and midrib of the leaf where moisture is superabundant, but its spread is very rapid, the small blackened areas increase in size,

become confluent, and sometimes within thirty-six, or at most forty-eight hours, not only is the whole leaf affected, but the entire contents of the curing barn may be rendered quite worthless as tobacco. Examination shows that the leaves have changed from greenish-yellow to a dark brown or almost black color, that the fine texture has disappeared, and that instead of being tough and elastic, the whole leaf is wet, and soggy, and tears almost with a touch, falling of its own weight from the stalk.

The severity of the disease varies, as has been said, with the atmospheric conditions of warmth and moisture, and certain years, e. g. 1872 and 1878, are memorable in Connecticut, as having been peculiarly conducive to the disease. The 10th Census of the United States is authority for the fact that the weather throughout the curing season of those years was damp and foggy. It is, however, safe to say that a tobacco crop is very seldom, if ever, cured in Connecticut without showing some trace of disease. Even during the most favorable seasons the disease does make its appearance in the center of the curing barn where the temperature is higher and the moisture more retained in and about the leaves, whereas in unfavorable seasons the loss has often amounted practically to the entire crop.

Finally, the disease is not peculiar to Connecticut. The Station has been in correspondence with the principal tobacco-growers of Virginia and Kentucky with reference to the subject and the replies have been invariably that the disease is well known in both States, and that it is induced or aggravated in air-cured tobacco—that is, tobacco cured without the aid of artificial heat—by hanging the tobacco too closely crowded in the barn to admit of the free circulation of the air; by hanging it when moist or wet from dew or rain, and by fogs penetrating the barn; or by the prevalence of damp sultry weather.

The past curing season in this State was exceptionally favorable to the tobacco grower, so much so that it was found impossible to secure specimens of diseased leaves for examination at the Station until the latter part of October. It was then learned that the disease had made its appearance at Melrose, and had destroyed in thirty-six hours, 2000 lbs. of Connecticut seed leaf. A quantity of the diseased material was sent to the Station, and was there subjected to thorough microscopic examination. On the less damaged leaves the appearance was as described above, but a small hand-lens revealed in the center of each blackened

spot, a minute, elevated pustule. Sections through the center of one of these pustules showed that the tissue of the leaf was largely disintegrated, and the cells themselves were completely filled with bacteria, which as they issued from the cells in vast numbers, gave a milky appearance to the water in which the section was lying. This being presumably the incipient stage of the disease it was only necessary in order to trace its development, to select a series of leaves showing more and more advanced stages of decay and to examine the pustules successively. This method showed that the bacteria develope rapidly in the tissue of the leaf, raising the epidermis, and finally breaking through at one or more points in the blackened area. Oozing through the ruptured tissue, they spread out in a thin slimy film over the surface in the immediate neighborhood of the pustule, finally forming a brown, translucent crust of a cheesy consistency, and composed entirely of the bacteria themselves. It was now an easy matter to take a minute portion of this crust, place it in a drop of distilled water through which it at once became disseminated, and examine it under the microscope, or transfer a portion of it to some nutrient material, liquid or solid. Examination with the microscope showed that there were invariably two forms of bacteria present, and only two—one in the shape of minute rods very rarely connected in chains, and belonging therefore to the genus Bacterium, the other consisting of spherical cells often united in chains and belonging to the genus Micrococcus.* It must be noted that two forms of bacteria very similar to those described—a Bacterium and a Micrococcus—always accompany, and are taken to be the active agents in, putrefaction whether of vegetable or animal substances, and the question naturally arises whether we have here merely a process of fermentation and putrefaction (whatever we may mean by these terms) common to all putrescible substances, and induced by the previous growth of some fungus on the diseased spot, or whether we have to do with specific agents of disease peculiar to tobacco.† A fungus related to one of the common leaf-dis-

*The dimensions of these two forms are: Bacterium, $1.9\mu - 3.7\mu \times 0.8\mu$; Micrococcus, spherical, $0.9\mu - 1.4\mu$ in diameter.

† In this connection it is well to note that a German investigator, Emil Suchsland, has recently discovered living organisms belonging to the groups Bacteriaceæ and Coccaceæ, associated with the process of fermentation of all kinds of tobacco. "Generally," he writes, "only two or three species are found on each kind of tobacco. Bacteriaceæ predominate, but Coccaceæ also occur. That these

eases of the tomato, of the genus Cladosporium, does occur in spots on tobacco leaves. Leaves partially cured, that is, leaves taken at the period when the "pole-burn" usually makes its appearance, but free from any developed fungus and bacterial disease, were kept in a damp atmosphere for some days. Under these conditions there developed on the leaves in the course of a few days, small brown spots of a velvety appearance under the microscope, the Cladosporium mentioned above. This fungus caused no wide-spread damage to the leaf, being limited to the very small spots in which it first appeared. In the course of six weeks, however, examination showed that the fungus was decaying rapidly and that in its place vast numbers of bacteria were developing, identical with those found in the pole-burned leaves. The gross appearance of the decaying areas was similar to that characteristic of "pole-burn," though owing to the fact that the leaves were by this time almost thoroughly cured, the spread of the decay was not so rapid. Finally, mingled with the bacteria in the pustules of leaves undoubtedly afflicted with "pole-burn," there were often found the remains of a fungus identical with the Cladosporium above mentioned.

We may therefore infer, although conclusive results can only follow further examination, that "pole-burn" is due primarily to the growth of a fungus upon the leaf, which by disintegrating and partially destroying the tissue of the leaf, gives access to a bacterial process of decay.

Were it not for this process of decay, however, we should have little to fear from the Cladosporium. The latter, as we have seen, is very limited in its area of growth, but the reproductive activity of the bacteria is very great, and the decay which they cause spreads with corresponding rapidity. For this reason the investigations undertaken in the laboratory have been upon

bacteria are the active agents of the ferment of tobacco is shown by the fact that if pure cultures are made from one kind of tobacco and another kind is inoculated with this pure material, there is reproduced in the latter tobacco the flavor and aroma characteristic of the original tobacco." By making use of the proper forms of bacteria Suchsland succeeded in so improving the quality of German domestic tobacco that experienced judges were unable to recognize it. E. Suchsland, Ueber Tabaksfermentation. Ber. d. deutsch. bot. Ges. Band ix, Heft. 3 April, 1891, pp. 79–81.

It may be therefore that the damage to curing tobacco known as "pole-burn" is merely an abnormal development of the same bacteria which are the active agents in the subsequent process of fermenting or "sweating" of the tobacco.

the bacteria themselves and the means by which their activity may be prevented. It is a matter requiring only delicate manipulation, to isolate the bacteria from the "pole-burned" leaves, and to obtain pure cultures. These were made in test-tubes on both solid and liquid media. The bacteria developed readily on potato-agar with a slight percentage of tobacco-ash or a trace of peptone, on slices of sterilized potato, and in potato broth with a trace of peptone. The sterilized potato gave the best results, and the cultures have been continued on that substance. Under these conditions the bacteria form on the surface of the potato round, or elongated and irregular colonies, of a slimy consistency, varying in color from livid gray to deep orange, and producing in the potato a dark stain beneath and around the colonies. In liquid media they develope, not on the surface, but as a flocculent deposit in the liquid. Certain facts may now be noted and compared with facts ascertained in the curing of tobacco.

(1) As the cultures become dry, the bacteria cease to develope so rapidly, and finally their development ceases. They require therefore moisture for growth, and decreasing the amount of moisture decreases their vitality. This bears out the general view that the origin and spread of "pole-burn" is in some way connected with an excess of moisture in the curing-barn.

(2) Nine tubes containing each a slice of sterilized potato were inoculated with the bacteria. Of these, three were kept at a temperature of 100° F., three at a temperature of 70° F., and the remaining three at a temperature of about 40° F. At the end of three days the tubes kept at 70° showed the usual growth, the colonies averaging 1½ inches in length by ½ inch in breadth; neither of the other sets of tubes showed any marked growth, but upon being placed at the medium temperature for forty-eight hours the development of the bacteria proceeded with marked activity. These experiments were repeated at various degrees of temperature. Temperature therefore has a marked influence upon these germs; warmth, up to 70°, and even 90°, is favorable to their development, whereas temperatures above 100° or 110° and below 35°–40° act as a temporary or permanent check upon their vitality. To this fact again we find a corresponding theory, that warmth as well as moisture is conducive to "pole-burn." Inasmuch as in this regard bacteria, as a rule, follow the laws governing the active growth of the higher fungi, it is immaterial at present to decide whether the former or the latter are the primary

cause of "pole-burn," since the means which may be recommended to prevent the decay, apply equally well to arresting or preventing the growth of the Cladosporium.

(3) One more fact should be stated, viz: that all attempts to inoculate thoroughly cured tobacco with the bacteria, failed. This result is partial confirmation at least of the generally expressed view that when tobacco has cured to a certain degree, the period varying from ten days to three weeks after hanging, there is very little danger to be apprehended from "pole-burn."

Remedial Measures.

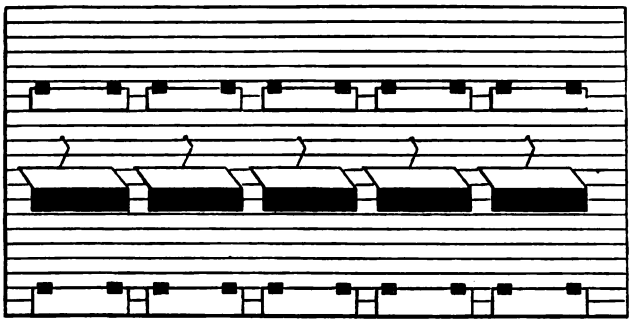
"Insufficient or badly managed ventilation is the chief cause of bad curing."*

We have seen that whatever is the primary cause of "pole-burn," its ill effects can be in a large measure, if not entirely, prevented by a proper regulation of moisture and temperature. Our first care therefore should be to provide a weather-proof building in which to cure the tobacco, so that if the external air should by reason of rain or fog become surcharged with moisture, the curing tobacco may be rendered independent of such a condition. This is comparatively a simple matter. At present the barns used for curing tobacco in Connecticut are, as a rule, anything but weather-proof; they are generally roughly built, and the air within them is, even when the doors are closed, practically in the same condition as the outside air, whether the latter be dry or moist. Under such conditions it is only to be wondered at that a crop is ever cured satisfactorily. The first step then, should be to render the existing barns as far as possible weather-proof, by covering them with water-proof paper and sheathing, or by any other means which commends itself to the common-sense of the grower. Having secured this condition, the next step should be to secure free ventilation. Not only does an excess of moisture in curing tobacco come from the external atmosphere if the barn is not weather-proof, but the tobacco itself in the process of curing gives off a large amount of moisture, and if fermentation takes place, a considerable degree of warmth is generated; so that even if the barn should be weather-proof, there exist within it all the conditions favorable to the development of "pole-burn."

*Tenth Census of the United States, 1880, vol. iii, Report of J. B. Killebrew, p. 107.

Ventilation.

This excess of warmth and moisture can be remedied only by a complete system of ventilation. Fortunately such a system can be readily and cheaply adapted to the existing tobacco-barns. It should be such that when the weather is sufficiently dry to expedite the curing of the tobacco, air can be admitted freely and can circulate *from below upwards*, in order that the warmth and moisture generated by the tobacco shall be carried up, and out through ventilators in the roof, being displaced by the dry air coming in from outside. The best method to secure free and uniform ventilation is to have a row of *horizontal* ventilators near the



ground, a similar row for each tier of tobacco, and one or more large ventilators along the ridge-pole. The ventilators in the walls should open *horizontally* at intervals of about four feet as shown in the cut. They should be from five to ten feet long, one foot high, hung from the upper edge by strap hinges so as to be raised and hooked up, and occupying the full length of the building. When these are all open, the air will enter freely, not only near the ground, but also just below each tier of tobacco. Free ventilation in the roof to allow of the escape of moist, warm air, is absolutely essential. This can be secured by large cupola ventilators placed at intervals of twenty or thirty feet along the ridge-pole and reinforced by openings under the eaves, or better still the ridge-pole may be occupied by a continuous slat ventilator running the full length of the barn and reinforced if necessary by a similar ventilator midway down the slope of the roof on both sides.

We have thus secured, at a very slight expense, a free circulation of air through the barn and an outlet for the accumulating

moisture from the leaves, when the weather is dry; and at the same time, in case of a period of prolonged damp weather, the barn can be rendered weather-proof and the curing can proceed in a measure independently of atmospheric conditions.

It must, however, be remembered that we are not aiming merely at rapid *drying* of the tobacco. The terms "drying," and "curing," are by no means synonymous. The change of color in curing tobacco is largely due to a process of fermentation which takes place in the hanging tobacco, and for which a certain amount of moisture in the leaf is a prerequisite. If the leaf is dried too rapidly this fermentation is either prevented or checked, and the result is a disagreeable, sickly green color in the product, instead of the rich brown desired. With a weather-proof barn, well provided with ventilators, the curing of the tobacco may be made to proceed as rapidly or as slowly as the circumstances, and the desired quality of the product, demand, in other words the process of curing, and therefore the result, under these conditions, depends only on the good judgment of the one in charge of the operation. If the tobacco is not curing rapidly enough owing to damp weather, the barn can be tightly closed; if, on the other hand, the process is proceeding too rapidly, the barn may be closed by day and opened by night; or if more moisture still is required, it may be closed and the floor sprinkled with water. If again, the weather is hot and dry, so much so that the rays of the sun will bleach the leaves, the barn can be closed so as practically to exclude both light and air.

With regard to the floor of the barn, the older barns of this State have dirt floors, and inasmuch as the "dampness arising from the ground is supposed to exercise a beneficial influence on the curing process,"* there seems to be no present necessity for a change in this respect, which would involve considerable expense.

Changes induced in the process of Curing.

We have thus far seen the advantages to be secured in the curing of tobacco by conducting the process in a weather-proof barn where ventilation and hence the influence of atmospheric conditions is to a great degree under control. But even under these conditions a successful cure will depend largely upon good management. Tobacco which is very rapidly dried out by means

* Tenth Census of the United States, 1880. Report of J. B. Killebrew, p. 248.

of a constant current of dry air, especially at a high temperature, undergoes very little, if any, chemical change, and retains to a greater or less degree its green color. Moreover, since the process of fermentation in bulk, accompanied by heat, depends upon and must be preceded by the changes in the leaf produced by gradual curing, it follows that tobacco which has been too rapidly dried loses to a great extent its ability to pass through the process of subsequent heating and sweating in bulk, and the greenish color remains permanent.

If the tobacco is dried in a current of air, care being taken not to drive the moisture out too rapidly, a change takes place in the interior of the leaf characterized by a change of color from green to brown, and the formation of *nitric acid* as a product of partial fermentation.

Finally, if tobacco is hung so closely as to prevent the free access of air, the color changes to brown, but *ammonia* is formed as a product of fermentation, the leaf loses its tenacity, becomes subject to "pole-burn," and decay follows to a greater or less extent.

These facts have been stated at length by two German investigators,* and are borne out by experience in this country.

It follows therefore that to secure immunity from "pole-burn" we must not only have the ventilation of the barn itself under our control, but the utmost importance must be attached to the method of hanging the tobacco so as to secure free circulation of air about each leaf.

Methods of Curing.

This brings us to a consideration of the two methods now in vogue of hanging tobacco, the older method of cutting and hanging the whole stalk with the leaves attached, and the method of detaching the leaves from the stalk before hanging, a method which is comparatively new in this country, but is almost universally employed in Germany and France. It is not our intention at present to discuss the merits of either method, inasmuch as the data at hand are not such as to warrant such a discussion. It will be well, however, to state briefly the arguments which are generally adduced for and against each method, and thus enable

* Nessler, Der Tabak, seine Bestandtheile und seine Behandlung, pp. 109, 110. L. von Wagner, Tabakkultur, Tabak- und Zigarrenfabrikation, pp. 34–38.

each grower to act as seems to him best, reserving any expression of opinion until further observation warrants such expression.

In the Tenth Census of the United States, (p. 44 of J. B. Killebrew's Report) various reasons are given showing the advantage of curing the leaves separately, over the method of stalk-curing. The advantage first stated is that all the leaves may be harvested when just ripe, and that therefore the crop shows a greater weight per acre. This is an undoubted advantage if absolutely true. That depends, however, on whether tobacco leaves attached to the stalk, do or do not mature after the stalk is cut, that is, whether the leaf feeds from the stalk during the process of curing, or the stalk from the leaf, or whether there is no appreciable transfer of material one way or the other. Upon this point opinions differ. One undoubted authority on the subject says: "Cut twigs or herbs yield to their leaves, etc., the water and the dissolved nutriment which the stems contain. The course is always from stem to leaf so far as the expenditure is concerned. Hence leaves and fruit grow heavier under such circumstances, as is well shown in the ripening of grains on cut wheat. But the same nutriment which is called for by the leaf, etc., is also likely to be used by new buds, and hence (when this happens) the leaves suffer. Practically when tobacco is cut and new buds (suckers) do not start or are arrested before they get very far, the leaves gain in dry weight, and that is a distinct advantage."

This view is also borne out by Wagner* who says: "If the leaf is picked before it is ripe, it needs a process of subsequent ripening to give it a good quality. This is impossible if the leaf is separated from the stalk, but it takes place to perfection under the American method" (the leaves cured while still attached to the stalk). With this view another German writer, W. Tscherbatscheff,† also agrees. On the other hand an experiment conducted by Nessler‡ shows that the dried constituents of tobacco leaves cured on the stalk, and separate from it, show no appre-

* Wagner, l. c. p. 38.

† Tscherbatscheff, W. Der Tabak und seine Kultur in den nordamerikanischen Staaten, Landwirthschaftliche Jahrbücher, 1875, p. 102.

"The weight of tobacco leaves cured on the stalk is 15 per cent. greater than that of leaves cured separate from the stalk."

‡ Nessler, l. c. p. 111.

ciable difference in weight;* and finally, going to the other extreme, a recent experiment conducted at the North Carolina Experiment Station with a view to settling the matter, indicates that a comparison between the weight of one half of a crop of tobacco cured on the stalk, and the other half cured separate from the stalk, shows a difference of weight of 128 lbs. per half acre in favor of the latter. These opinions are irreconcilable at present; but there is certainly a possibility that the leaves may mature and increase in weight while attached to the cut stalk, and that the curing of the two together may therefore yield as large a weight as when the leaves alone are cured.

There is, however, another point in this connection. We are aiming to secure free circulation of air about each leaf, so that, other things being equal, it is merely a question which method will best accomplish this. It has been argued very rightly that by stripping the leaves they can be hung much more loosely, that is, farther apart, and that the crop can be cured more quickly.

But as has been seen, the latter is not always an advantage, and if circulation of air sufficient for gradual and continuous curing is obtained when the entire stalk is hung with the leaves attached, our object is fully attained and a looser method of hanging is not absolutely necessary. Whether that object is attained by this method is, however, very doubtful, experience seeming to show that those leaves which are more or less covered by the overhanging leaves of the stalk are most subject to the attacks of pole-burn.†

* The following figures representing the results of this experiment are copied from Nessler's work.

Calculated from dry material, 100 parts of tobacco contain:

Dried.	Ash.	Total Potash.	Soda.	Carbonate of Potash.	Nitrogen.	Fat.
No. 1. On the stalk ..	22.02	4.62	0.67	3.62	2.34	
Leaves alone..	23.24	4.65	0.59	3.46	2.00	
No. 2. On the stalk ..	24.57	3.24	0.36	0.27	4.66	5.20
Leaves alone..	23.22	3.26	0.46	0.35	4.22	5.00
No. 3. On the stalk ..	22.12	3.79	0.19	2.43	3.25	4.93
Leaves alone..	22.86	3.84	0.24	2.88	3.96	4.56

† Upon this point Nessler (l. c. p. 110) writes: "In many localities the stalk is cut with the leaves and both cured together. It cannot be denied that with due care this method presents many advantages. The leaves never hang so close together as to prevent the circulation of air, consequently more nitric acid and less ammonia is formed, and the leaves are less liable to rot. By this method the tobacco cures better, especially as regards the burning quality."

The questions of the final weight of the product and the free circulation of the air are not the only ones to be considered in this connection. It is urged in favor of picking the leaves that the different qualities may thus be kept separate from the start, and that therefore less time is required for preparing the product for market; that the saving of barn room is considerable, six tiers containing leaves only, being accommodated in a space large enough for only four tiers containing both stems and leaves; that the physical strength required to strip and hang the leaves alone, is much less than when the stalks are cut and hung, and can therefore be done by girls and boys at slight proportional expense; and finally that the second crop of suckers and leaves arising from the stalks left standing, if ploughed in, forms a most valuable fertilizer, superior to the dried stalks.* It might be further urged that it is difficult to dissipate the excess of moisture given off by the large, juicy stalks in the curing process, that the process is thereby unnecessarily delayed, and the leaf decidedly endangered. This objection to stalk curing is certainly a most striking one in any section where tobacco is cured by air only, without artificial heat, and merits the serious consideration of the Connecticut growers.

To sum up on the other side, the added expense of the method of picking and hanging the leaves alone, including as it must the initial expense of special devices for hanging the leaves,† must be an objection in the mind of every grower of tobacco, unless he is convinced that the superior quality of the product, and the consequent increase in its value; the saving of time; and therefore of money, in the process of curing; and the increased immunity from "pole-burn" attendant upon a less crowded method of hanging the tobacco, outweigh the increased expense of harvesting. Enough has been said upon these points to enable a grower to decide the matter for himself as conclusively as it is possible at present for

*It sometimes happens that the earlier hatched "tobacco worms" or "horn-caterpillars" complete their transformation on the first crop of tobacco. The moth then lays eggs upon the second growth in the fall, and it is in order to destroy this second brood that the ploughing in of the second growth is often recommended.

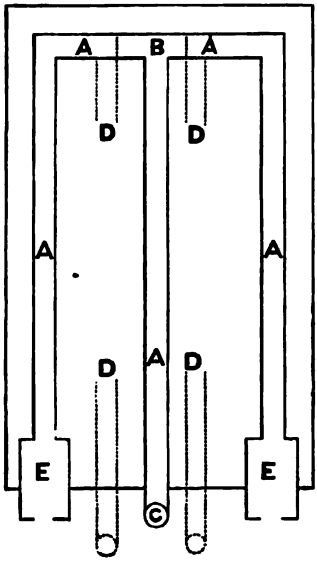
†The wired sticks used in what is known as Snow's Modern Barn System are quoted at $5.00 per 100 cash, or $6.00 per 100 on time. Similar curing sticks provided with wires are manufactured by the Tobacco Hanger Manufacturing Co., of Houston, Va., and are quoted at $3.00 per 100 cash or $3.50 per 100 on time.

anyone to decide it. Opinions differ regarding this added expense. One grower in Virginia writes: "The cost of leaf curing is from actual experience much greater than in curing the entire plant and I have failed to find any compensating advantages to be derived from it." Another grower in Kentucky says: "I do not believe that the advantages received from stripping the uncured leaves, if there are any at all, compensate for the additional labor." On the other hand, Maj. Ragland, perhaps the largest grower of tobacco in Virginia, writes that he has for years employed both methods with success, and there is no doubt that in parts of Virginia and North Carolina the method of stripping the leaves has recently come into decided favor.

The Employment of Artificial Heat.

We must, however, pass to another measure which, when properly employed has, as far as we can learn, never failed to prevent "pole-burn," viz: the use of artificial heat, when necessary, during the process of curing. It has been more than once suggested that any machinery that could be devised to ensure active circulation of air through the barn, would, even in damp weather, prevent the occurrence of "pole-burn." It seems difficult to believe, however, that a disease, the harmfulness of which is largely due to warmth and moisture, would be materially checked by a free supply of warm, damp air, even though that air were in motion. It would seem more reasonable to dry the air in the barn by means of the application of artificial heat conducted by flues. In many sections of the country, especially in the South, where the tobacco industry has been long established, this method of curing has largely superseded air-curing. It is quite possible that in our climate we may secure immunity from "pole-burn" by merely altering our barns as already suggested, so as to ensure the interior from unfavorable atmospheric conditions, and at the same time provide for free ventilation; but when we have taken this step, it may prove merely preparatory to the final step of providing the existing barns with artificial heat. At any rate, inasmuch as this would undoubtedly prove a remedy against "pole-burn," a few words on the subject cannot be superfluous. In a letter addressed to the Station under date of Dec. 10th, Maj. Ragland says: "I have never known tobacco cured by artificial heat to be damaged by "pole-sweat" or "house-burn," so called," and this is the testimony of practically all the growers

in the South and West with whom we have corresponded. This being the case, it remains to see how artificial heat conducted through flues can be adapted to the barns at present existing in Connecticut, for it goes without saying that it would be impracticable to build new barns for the sake of providing them with a simple system of flues, and that open fires in the barn would produce a markedly unfavorable effect upon "wrapper" tobacco. This is a matter involving by no means so great an expense as has been often imagined; the flues and simple furnaces are comparatively cheap, much of the work can be done by unskilled labor, and it is not even necessary to substitute board floors, for the earth floors which many prefer. The simplest method seems to be that figured and described on p. 192 of the Report on Tobacco already referred to in the Tenth Census of the United States, and figured in the accompanying cut. Trenches are dug in the floor of the barn 15 to 18 inches wide and of the same depth, the side trenches being 12 or 13 inches from the walls of the barn, AAA. These side trenches encircle the floor space on three sides of the barn, meeting at the center in the rear, B. Here they connect with a trench BC, running lengthwise through the center of the barn. If it is desired to keep this portion of the floor free for the admission of wagons, the plan suggested in the Census Report may be adopted, each side trench being continued down the center independently, as indicated at DD, leaving a free space running the full length of the barn in the immediate center. These trenches covered with sheet iron or fire-proof stone, preferably lined with brick, may themselves serve as flues; or sheet-iron flues 12 to 15 inches in diameter, such as are used for stove piping may be laid in them. In any case the side flues should rise gradually from front to rear, and the central flue or flues from rear to front, about 1 inch in 2 feet, so that the point where the latter issue from the front wall of the barn will be elevated considerably



above the point where the side flues issue from the furnaces. The side flues each connect with a furnace E E at the front of the barn. The furnaces must be sunk below the level of the ground sufficiently to permit of the flues entering the upper part; they may be built of fire-proof brick or of iron, or some simple form of ready-made furnace may be found to be ultimately cheaper. The plan described in the Census Report provides that the flues shall be *built up* 18 to 20 inches *above* the level of the floor instead of being sunk a like distance *below* that level. Such a flue would give off more heat, since the heat would be given off from the sides as well as from the top, and also would allow of the furnaces being but very little, if at all, below the level of the ground; but it would occupy a good deal of floor space, which would be saved if the flue were sunk below the level of the floor. It might be possible in the latter case to cover the trenches containing the sheet-iron flues with heavy planking. This could be removed when the fires were lighted, but when in place would render the whole floor space available. The size of the furnaces must depend largely on the size of the barn and the diameter of the flues. The Census Report recommends for a barn 20 feet square, a furnace 5 feet long, 18 to 20 inches square in cross section, and projecting outside the wall 18 inches. The larger barns in use in Connecticut would have to be provided with larger furnaces, the size of course depending upon the size of the barn and the size of the flues. This could be readily estimated by any experienced furnace builder or dealer, but would probably in no case exceed a length of 10 to 12 feet, and a width of 6 to 8 feet. Of course it is difficult to estimate the expense incident to providing artificial heat by the method suggested. The cost for heating a barn capable of holding 5 acres of tobacco would probably be below $100. The Census Report, p. 68, states that "a barn of ordinary size* can be fitted with brick-walled and iron-capped flues, including cost of arches for the furnaces, and chimneys for carrying off the smoke, at a cost of from $40 to $75, varying with cost of materials and labor.

Use of Artificial Heat.

There seems to be in the minds of many, an idea that the use of artificial heat is entirely to *dry* the tobacco, the quicker the

*With a capacity probably of 1 to 2 acres. If iron furnaces were used the expense would probably be larger.

better; and that the fires must therefore be kept up continuously at a considerable expenditure of fuel and labor. This is a mistake. It has been already shown that the process of curing is to a great extent a process of fermentation. To aid this process when other conditions are unfavorable, and to establish within the barn at critical periods conditions which shall prevent the occurrence of "pole-burn," are the only uses of artificial heat in this connection.

We cannot do better than quote at length from a letter on this subject recently received from Maj. R. L. Ragland, of Virginia, whose wide experience in the growing and curing of tobacco, gives weight to his opinion. He says: "I have never known tobacco cured by artificial heat to be damaged by 'pole-sweat' or 'house-burn' so-called. The heat evidently dispels or prevents any attack of bacterial disease and deterioration of the leaf during the curing process, except from scald or undesirable change of color due to excessive heat. Cigar tobacco requires very little artificial heat to cure properly—the heat should be used supplementally, and the temperature kept at a point that will keep the leaf drying *gradually*, but drying *all the time* until the moisture is entirely dispelled from the leaves. I have long advocated that all classes and types of tobacco are best and safest cured by the application of artificial heat to assist in drying, and this opinion is not based merely upon theory, but is found after trial in the curing of every class and type grown in this country. I have cured all of them with and without artificial heat, and give it as my opinion based on experience that tobacco cured over flues or stoves emitting no smoke is better than sun or air-dried tobacco. Tobacco of any class is more *speedily* and *thoroughly* cured by artificial heat than when air-dried, and it is a well known fact that tobacco thoroughly cured over flues will keep sounder than when air-dried."

We have heard the opinion expressed that tobacco cured over flues will not pass through a subsequent "sweating" or fermenting process. Others of experience have doubted that statement, and the doubt proves to be a reasonable one when the matter is tested. In the same letter from which we have just quoted, Maj. Ragland says, "Air-cured tobacco is not only the better for being "sweated" for months, but *requires* more time to complete this process than flue-cured tobacco. It is my experience that tobacco when bulked down 'in case,' viz: when it has absorbed enough

moisture to render it supple and flexible, will always pass though a "sweat" if it remains in bulk long enough. And this is the case with tobacco cured by artificial heat as well as when cured without that aid. I believe that flue-cured tobacco bulked down will *in a shorter time* be ready for the manufacturer than sun or air-dried tobacco, but all tobacco so cured passes through a slightly fermenting process accompanied by the generation of heat."

This is all that can be said at present with any certainty on the subject of the causes, mycological and atmospheric, of "pole-burn" of tobacco, and the means which have been successfully employed in combating it. This report is, however, only preliminary; the subject is still under investigation, and it is hoped that further experience will tend to clear up certain points which are still doubtful, and warrant the publication of a special Bulletin on the subject.

STEM-ROT.

There is at least one more disease of tobacco affecting the crop in the latter stage of curing which merits some consideration. The stalk of the tobacco plant is, as we should expect in so rapid a grower, exceedingly succulent and juicy. For this reason, the proper drying of it as necessitated when the whole plant is cured, is a long and tedious process, often accompanied with most undesirable results. This stalk after it has been cut for some days, and has become partially wilted, forms a most admirable field for the growth of fungi, especially for those which usually grow upon dying vegetation. One such fungus at least, has proved most troublesome in the curing barns, and from its pernicious action is commonly known as "stem-rot." If stems affected with this disease are examined, they will be found to be covered with pure white patches having the appearance of a long-pile velvet. These patches spread rapidly, encroaching upon the veins of the leaf, and destroying the tissue, and in the end induce a more or less wide-spread decay, especially in the neighborhood of the mid-rib and veins of the leaf, where the moisture is longer retained than in the delicate tissue of the leaf. The velvety appearance is due to the growth of the vegetative part, or "mycelium," of a fungus long known to botanists, and belonging to a group of fungi familiar to the vegetable pathologist. We may place it for the present in the genus Botrytis.

The vegetative threads of the fungus grow at first over the surface of the stalk, and penetrate it to a greater or less extent. In the course of time erect branches arise from these threads in great numbers, often attaining a height of a quarter of an inch, and producing the white velvety or furred appearance on the stalk. From these erect branches there soon arise shorter branches at right angles to the main branches, and finally at the tips of these shorter branches the fruit is borne in the shape of vast numbers of spores.

The fungus seldom reaches maturity on the curing stalks, for it requires some days and considerable moisture for its complete development, hence by the time the vegetative threads are ready to produce the fruiting branches, the stalks are too far dried to afford the requisite nutriment. After the curing process is completed, however, the tobacco is taken down, and the stalks and leaves most seriously affected with "stem-rot" are thrown down on the floor with the refuse which always remains after the curing of a crop of tobacco. Here on the damp earth floors and in company with decaying stalks and leaves, the "stem-rot" fungus finds all the conditions favorable to its farther development. The fungus spreads among the refuse, and produces its spores in enormous quantities. It is not unusual upon entering a barn even during the process of curing, to find the floor partially covered with the refuse of the previous year's crop, the latter often looking as though a fall of snow had whitened it, so densely is it covered with the mycelium and spores of this fungus, named on account of its long fruiting branches or arms, *Botrytis longibrachiata.** The slightest current of air serves to separate the spores from their attachment, and carry them through the barn, some finding lodgment upon and at once infecting the curing stems and leaves, others being deposited on the beams or walls of the barn and there remaining to propagate the disease another year.

Remedial Measures.

Against such a pest absolute cleanliness is the best and simplest precaution. After the crop is cured, all the diseased stems and leaves should be carefully collected and at once burned before the fungus has reached maturity. All the refuse remaining on

* This fungus is not peculiar to tobacco but occurs on various dying or dead herbaceous plants.

the floor of the barn should then be thoroughly gathered together and burned, and the floor should be liberally sprinkled with a mixture consisting of equal parts of dry air-slacked lime and sulphur. If the floor is of earth, covering it to the depth of an inch with clean dry earth would prevent the dissemination of the spores through the air. A more effectual method of reaching the spores in all parts of the barn would be fumigation by means of sulphur, kept boiling for two or three hours in any iron vessel over a small kerosene stove. In the larger barns it would be advisable to have three or four such stoves, and keep the sulphur boiling simultaneously in different parts of the barn; of course during the process of fumigation the building must be kept tightly closed so that the fumes may thoroughly penetrate every part. If this were done once after the removal of the cured tobacco, and again the following season a fortnight before the tobacco is harvested, the danger from "stem-rot" would be largely decreased if not entirely obviated.

In closing this report upon tobacco we wish to express our sincere thanks to Maj. R. L. Ragland, and Messrs. E. R. Cocke and W. T. Sutherlin of Virginia; to Messrs. Leslie Combs, A. P. Gooding, W. Z. Thomson, and Lewis L. Johnstone of Kentucky; and to Messrs. Austin and Pinney of Suffield, Conn.; all of whom have furnished most valuable information in connection with the subject.

NOTES ON THE CURING OF HAVANA SEED LEAF TOBACCO BY ARTIFICIAL HEAT.

The system of curing tobacco on the stalk in barns which are not weather-proof, or being weather-proof cannot be properly ventilated in very unfavorable weather, nor heated at any time, is almost universal in this State. The faults of the system are also universally recognized. In a very favorable season the curing is all that could be desired. In a clear dry season, like that of 1891, the cured tobacco is apt to show considerable "white vein;" *i. e.* the veins cure white and shining and make the affected leaves worthless for wrappers, a fault ascribed by growers to too rapid drying of the veins.

On the other hand, if warm, moist, ("muggy,") weather prevails for ten days after cutting the crop, it is sure to be associated with prevalence of "pole-burn" which may ruin from a tenth to a half of the entire crop, or in extreme cases actually the whole of it. "Stem rot" is another disease believed to be peculiar to pole-cured tobacco. These diseases of tobacco are discussed in the report of the mycologist, Dr. Sturgis.

Leading tobacco growers admit that the present system of pole-curing is very crude and unsatisfactory, chiefly for the reason that the owner cannot control the heat and moisture in his barns enough to prevent "pole-burn." It is admitted that artificial heat alone or with a supply of moisture at the same time might prevent this disease without damaging the color or texture of the leaves. It is also true that in past years no method to do this has been devised successful enough in Connecticut to warrant general adoption.

The Snow Modern Barn System.

A new process of harvesting and curing tobacco, the so-called "Snow Modern Barn System," was introduced into this State last season as an experiment, and the Station was asked by tobacco growers in Suffield to make observations on this mode of curing; particularly to test the conditions of heat and moisture in the barn while the curing was going on.

It is not necessary here to fully describe the barn and apparatus. Suffice it to say that the Snow Modern Barn System as a system of *curing* tobacco (certain important advantages are claimed in harvesting) consists in this. The fresh leaves, stripped from the stalks in the field are brought to the barn in baskets and strung through the butt back to back, about the width of a finger apart, on pointed wires which project at right angles from a wooden "stick."

As the "sticks" are filled they are placed in moveable racks in a barn and as fast as a rack is filled it is raised by a simple device to the top of the building. Other racks follow leaving only as much space between racks as is required for the hanging leaves.

The barn by a very complete system of ventilators can be closed tight or thoroughly ventilated. The floor is of slats and in the cellar are two small furnaces or stoves and a system of flues which exposes a large radiating surface and makes it possible to warm all portions of the floor space above evenly.

When the barn is filled and the leaves wilted, the heat is raised considerably above that of the air outside and held there. The moisture, however, is not allowed to escape freely from the building but the air of the barn is nearly saturated with it. Soon a "sweat" begins in the tobacco which produces more water and following shortly after, the leaf begins to change color, but without drying. The curer watches the color, regulating heat and moisture as experience has taught is necessary and when the color wanted is obtained he raises the heat and diminishes the moisture to "fix" the color. Finally the leaves become dry and the cure is done. It is only necessary then to moisten the leaves, which is quickly done by sprinkling water on the basement floor and leaving the building closed for sometime. The tobacco is then removed from the wires and bulked down to sell. The above is a brief outline only of the "System." The Modern Tobacco Barn Co. claim patents to cover "all tobacco sticks with projecting prongs on each side, at right angles to the stick, by any and all permanent means of attachment, no matter how attached or fastened."

The following advantages of this method are claimed by the representative of the company:

1. All loss from "burn," "stem rot" or "white vein" is avoided.

2. A more uniform color is secured than by pole curing.

3. Better control of the color is possible, *i. e.* it can be made dark, medium or light as the market demands.

4. Great saving of time is effected in curing the crop.

5. The tobacco so cured will not "sweat" as pole-cured tobacco sweats in the case, but only requires a short "mull" in bulk, to fit it for immediate manufacture.

The Experiments at Suffield.

In the spring of 1891 the Modern Tobacco Barn Co., through their agent, Mr. J. B. Roney, constructed a barn on Mr. H. H. Austin's farm in Suffield, at their own expense, and in the late summer and fall made several experimental curings of Havana seed tobacco grown in that town. Mr. E. F. Paschal who conducted the curings has had a wide experience with southern smoking tobacco, but as far as known the system had not been applied before to the curing of wrapper tobacco which is the only kind raised here. Mr. Paschal said at the outset that because of this difference in the character of the tobacco it was not to be expected that the first few trials would be perfectly successful. Experience would be needed to secure perfection of color in the curing.

The experimental barn was quite small—twenty feet long, sixteen feet wide and twenty feet high, with four sets of stanchions. About thirty thousand leaves can be conveniently cured in this barn at a time. The barn and fixtures were made on the same plan as those which are used in the South. The furnaces are made to burn wood. Should the method be introduced here probably coal or steam would be found cheaper and more convenient requiring less attention from the curer. In this experiment about a cord of hard wood was used in each curing.

Owing to the close attention required to the details of the curing process the representative of the Station was unable to gather data regarding the cost of picking the leaves and filling the barn, and indeed the only point which the Station was asked to investigate was the conditions of heat and moisture in the barn during the curing process. It was understood that the quality and quantity of the Modern Barn-cured tobacco as compared with the pole-cured would be determined by the growers themselves.

Mr. Winton of this Station witnessed the second and third curings and with an assistant made observations of the tempera-

Observations of Temperature and Relative Humidity in the Snow Modern Barn During the Curing Process.

Date.	Weather.	Temperature.					Relative Humidity.			
		Outside.	In the Curing Barn.				Outside.	In Curing Barn.		
			First Floor.		Second Floor.	Third Floor.		First Floor.	Second Floor.	
			Front.	Rear.						
August.										
22, 5 p. m.		85	85	92	89	92	56	85	--	
9 "		72	89	93	94	94	82	100	--	
23, 2 a. m.		64	87	91	92	93	93	100	--	
6 "		62	87	91	92	93	98	100	--	
10 "		77	93	96	97	100	75	96	--	Leaves wilting perceptibly.
2 p. m.		85	96	101	100	102	61	86	--	
6 "		79	96	103	100	103	70	86	80	[at 7.30.
10 "	Heavy shower about 11 o'clock.	74	98	105	105	110	91	87	78	A few pails of water sprinkled in basement
24, 2 a. m.		70	96	98	100	103	100	90	80	Leaves beginning to turn yellow.
6 "	Damp and rainy following clear sunrise.	69	93	97	98	102	98	89	81	One fire out for short time.
10 "	Mist and rain.	76	96	100	100	105	94	88	77	
2 p. m.	Sunshine at 12 m.	83	97	104	101	106	77	85	77	
6 "		80	96	108	102	106	78	78	69	
10 "		76	95	101	100	106	93	81	77	Leaves fully wilted and decidedly yellow on
25, 2 a. m.		74	93	98	98	106	91	82	76	tips and in spots.
6 "	Clear day.	74	95	100	101	107	91	81	71	Leaves brown on tips and in spots.
10 "		81	96	100	101	105	71	79	71	Six pailfulls of water added at 9.30 a. m.
2 p. m.		83	96	101	100	105	53	78	67	
6 "		77	96	101	100	106	63	76	65	
10 "		69	93	98	99	102	72	78	66	
26, 2 a. m.		66	90	96	96	100	80	77	67	
6 "	Cloudy.	65	91	98	98	105	80	74	64	
10 "	Few drops of rain at noon.	71	97	102	103	107	71	73	64	Strong tobacco odor in barn for first time.
2 p. m.		73	98	102	103	108	78	73	67	
6 "	Light rain till 6 a. m. of 27th.	72	97	102	103	106	88	75	67	
10 "		70	95	104	105	111	93	74	65	
27, 2 a. m.		69	93	98	100	105	97	75	65	The leaves were about one-quarter brown
6 "	Dense mist.	67	96	101	102	108	100	80	63	
10 "		70	101	107	107	113	91	70	60	Tobacco odor in barn almost unendurable.

Observations of Temperature and Relative Humidity in the Snow Modern Barn During the Curing Process.

Continued.

Date.	Weather.	Temperature.					Relative Humidity.			
		Outside.	In the Curing Barn.				Outside.	In Curing Barn.		
			First Floor.		Second Floor.	Third Floor.		First Floor.	Second Floor.	
			Front.	Rear.						
August.										
27, 2 p. m.	Shower at 3.00 p. m. Then "open and	77	102	106	107	112	84	69	60	
6 "	shut" weather.	77	101	106	106	111	89	71	64	
10 "		73	100	106	106	111	95	67	59	
28, 2 a. m.		73	98	104	104	110	95	65	59	
6 "		72	102	109	109	115	97	62	54	Browning of leaves continues.
10 "	Shower.	78	103	109	109	119	84	63	55	Opened two top ventilators.
2 p. m.	Rain.	73	102	107	107	109	93	62	55	Most of the leaves are brown except on the
6 "	High wind began at 8 p. m.	74	106	112	111	119	86	58	54	ribs The midribs are still juicy or "fat."
10 "		66	106	112	112	115	66	50	40	Leaves near the door still greenish.
29, 2 a. m.		60	97	100	103	107	65	43	37	Till now the midribs have not cured much.
6 "		56	97	97	98	105	65	37	31	Ventilators shut. Midribs drying.
10 "		60	115	122	123	137	63	42	35	Tobacco odor still very strong
2 p. m.		71	114	118	118	128	52	39	38	
6 "		65	116	124	122	136	61	39	34	
10 "		60	132	140	140	162	73	--	31	
30, 2 a. m.		58	124	129	133	147	89	31	28	
6 "	Rain toward morning.	58	127	133	135	147	94	24	23	
10 "		58	128	135	136	148	94	23	20	Midribs almost dry except by door.
2 p. m.		60	142	151	151	169	95	22	20	
6 "		60	149	156	156	171	84	16	12	
9 "		59	150	156	158	169	94	12	10	Fire left to go out.
31, 8 a. m.	Cloudy day.	60	84	86	86	88	68	34	35	Opened top and bottom ventilators and added
12 m.		66	70	75	74	79	61	73	58	about 50 gallons of water. [added.
5 p. m.		67	74	77	78	80	81	88	63	At 3 p. m. leaves getting pliable. Much water
7 "	Few drops of rain.	63	70	73	74	75	89	82	82	Opened all doors and side vents.
9 "		62	66	73	74	75	89	82	82	
September.										
1, 8 a. m.		61	61	--	--	--	89	--	--	Leaves fairly moist though midribs still rather brittle.

ture at five different places and of the relative humidity of the air at one place in the building every two hours day and night from 3 P. M. on Aug. 22 to 8 P. M. on Sept. 1.

The accompanying table pages 190 to 191 gives in detail the observations made by Mr. Winton. The term "relative humidity" signifies what portion (per cent.) of the moisture which air of the given temperature could possibly hold, was actually present at the time of observation.

The particulars regarding the weather, the temperature and humidity of the interior of the barn as well as of the outer air and of the progress of the curing are given in the table.

A study of the figures and of Mr. Winton's notes will make evident the following facts.

Some of the leaves near the door did not come to color properly and the thermometer hung near the door shows greater fluctuations than the others because very many people visited the barn during the curing and the front door was often opened. The manager was willing to allow this although knowing that it was a damage to the tobacco nearest the door.

The third story was throughout warmer and dryer than the lower part of the barn but the cure was as successful there as elsewhere.

The thermometer on the second floor showed the same temperature as the one on the first floor farthest from the door and the following statements refer to the mean of the readings of these two instruments and to the readings of the sling psychrometer on the first floor.

The time required for filling the barn and curing the leaves was just eleven days and may be conveniently divided into the following periods which are of course quite arbitrary and might differ considerably in different curings.

A	Filling the barn	12	hours.
B	Wilting the leaves	18	"
C	From time of starting the fire till the yellowing began	43	"
D	From yellowing till the brown color began to appear	24	"
E	From D till the rank odor developed	24	"
F	From E till leaves were mostly brown except on midrib	54	"
G	From F till color was satisfactory	18	"
H	Time of drying the midrib and fixing color	38	"
I	Cooling and dampening	34	"
		264	"

It should be said that this is twice as long a time as was required for curing the lower leaves which were picked and cured previously and probably considerably longer than was necessary. But as this kind of tobacco had never been cured before by this process, the expert, Mr. Paschal, wished to go surely if slowly.

Our observations began when the barn was closed and the fires built, at 1 P. M. Aug. 22, the beginning of period C.

1. From the time the fires were fairly going and the flues warmed till the yellow color appeared on the tips and in spots over the leaf, 39 hours, the temperature of the barn fluctuated between 91° and 105° and on the average was 97°.

The relative humidity in the barn was from 86 to 100 and on the average was 92, while that of the outer air averaged 82.

This is a nearly saturated atmosphere and while a good deal of water in the aggregate might evaporate from leaves four-fifths of whose weight was water when they were put in, there is nothing like a rapid drying.

2. From the time when yellow patches first appeared to the first signs of browning, period D, 24 hours, the temperature of the barn varied between 98° and 105° and on the average was 102°.

The relative humidity varied between 78 and 90 or on the average 83, while that of the outer air varied from 77 to 94 and averaged 86.

In this period the temperature has risen five degrees and the humidity has fallen slightly. The leaves are "sweating;" water stands on them in drops. Here again there is no doubt a slow drying but nothing like what would take place in even moderately dry air. The atmosphere of the barn is at this time almost insupportable because of the moisture.

3. In the following 24 hours, period E, the same state of things continues. Temperature between 96 and 101, averaging 99°; relative humidity 74 to 81, averaging 77.

At the end of this period note was first made of a "tobacco odor" difficult to describe but due to an exhalation that was intensely irritating to the eyes and considerably so to the throat. Analyses of the leaves before and after curing do not indicate any considerable loss of nicotine.

4. Next follows a longer period, F, of 54 hours, during which the tobacco odor is very strong, at times almost unbearable even for the time needed to make observations. In this period the

leaves are drying somewhat more rapidly, though entirely limp and damp to the touch, and the curer is waiting for the brown color to spread over the whole leaf and to become dark enough.

Temperature from 99° to 109°, averaging 105°.

Humidity from 62 to 80, averaging 70.

5. Next is a short period, G, of 18 hours, during which the air grows rapidly drier. This period might probably have been omitted and the heat raised at 2 P. M. on the 28th, but for greater security the curer waited.

6. In the last period of the cure the heat was run up to 157° simply to cure and dry out the midribs perfectly. When this was done it was only necessary to cool and dampen the leaves so they could be handled.

Curing of Upper Leaves and Miscellaneous Tobacco.

On Sept. 5 the top leaves from the stalks whose lower and middle leaves were cured in the first and second experiments were picked and put in the barn and as they did not occupy over a quarter of the space, the remaining space was filled with a miscellaneous lot of leaves from different fields.

Time of Observation.	Notes on Process.	Temperature (F).				Relative Humidity.			
			In the Building.				In the Building.		
		Outside.	1st Story.	2d Story.	3d Story.	Outside.	1st Story.	2d Story.	3d Story.
Sept. 5 and 7	Barn filled.								
" 8th, 8 A. M.	Fire started.								
" " 1 P. M.		63	77	79	81	60	95	87	83
" " 4 P. M.		63	81	86	86	60	88	73	77
" " 7 P. M.		58	83	86	87	72	92	77	77
" " 10 P. M.		52	83	85	85	84	92	80	77
" 9th, 2 A. M.		47	81	83	83	93	88	80	80
" " 6 A. M.	Yellowing well started	45	77	79	79	96	87	75	79
" " 10 A. M.		65	83	85	87	56	92	80	77
" " 2 P. M.		68	86	90	91	50	84	68	71
" " 6 P. M.		59	89	92	96	62	88	75	67
" " 10 P. M.		55	87	90	92	70	88	75	69
" 10th, 2 A. M.		48	84	86	87	93	84	73	74
" " 6 A. M.		46	82	85	87	96	80	73	67
" " 10 A. M.		68	89	92	95	60	88	78	72
" " 2 P. M.		75	97	101	104	47	86	74	69

As the leaves were of different degrees of ripeness and of different texture the curing did not proceed with the same ra-

pidity in all cases. The leaves from near the tops of the stalks cured much more rapidly than the others.

During this curing no water was added to the cellar except at the end of the process after the fires were out.

The record of temperature and moisture were taken for the first three days during the most critical part of the process and are given above.

It will be noticed that the temperature in this curing was kept for the first three days from 15° to 20° lower than in the previous curing but the relative humidity in the barn was fully as high if not higher than before. But the curing was equally successful.

Mr. Paschal stated that the heat in the building must be regulated somewhat by the temperature outside which was considerably lower in this curing than in the last. The curing was easily done in six days.

Curing of Stem Suckers.

The first curing, not witnessed by us, was of lower leaves picked by hand on a certain part of a tobacco field. The second curing, described in detail above, was of the middle leaves from which the prime long wrappers are made; the third curing just alluded to was of the shorter upper leaves.

When the lower and middle leaves were picked, from most of the stalks there grew a stem sucker. The season being an exceptionally long and favorable one, these suckers grew leaves of good size which appeared quite fairly ripe and all other tobacco being harvested the barn was filled with the stripped sucker leaves to see if they could be cured. Somewhat to the surprise of every one they cured almost as rapidly as the others. Their texture and color when cured were certainly all that could be desired. They added very considerably to the value of the crop.

It would have added greatly to the value of the observations if there had been opportunity to make notes of the weight of tobacco obtained and the cost of harvesting; and if samples could have been submitted to an expert, who was ignorant of their origin, for a judgment of their texture, color and burning quality comparing each with other portions of the same crop, pole-cured.

The representatives of the Modern Barn System were ready to coöperate in any plans but when the Station was called on by

tobacco raisers there was too little time to arrange for any thing more than was done.

The circular referred to in report of Board of Control, p. 11, is here reproduced.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

NEW HAVEN, CONN., November, 1891.

DEAR SIR:

It is said that a larger number of old, well established varieties of Indian corn are grown in Connecticut than in any other State in the Union.

Some of these have been raised in one place for more than a century, and during that time have been strikingly improved by selection.

It is very desirable that specimens of these varieties should be collected, with all available information regarding their names, origin, history, improvement under selection, and actual yield per acre. This is especially so in view of the Columbian Exposition at Chicago in 1893, where there should be a fair exhibit of the leading agricultural products of this State. It is also important that a full set of samples be kept in the State for the instruction of our citizens.

The collection should be begun at once, as it cannot well be made complete in one season. This Station, therefore, asks the coöperation of farmers in an attempt to prepare an exhibit of Indian corn which shall do credit to the State. To this end the Director invites Granges, Farmers' Clubs and Farmers to furnish this Station samples of corn selected from this year's crop, of those varieties which have been raised in Connecticut for a term of years, and of new kinds which are considered valuable.

Ten ears of field-cured corn (with the husk attached if possible) should be selected which fairly represent the *average quality* of the variety. Besides, four ears of extra size of each variety are desirable.

Each ear should be separately wrapped in plenty of dry paper, and the whole, tied firmly together, should be packed with straw

in a box; or, if that cannot be done, should be so carefully done up in cotton and stout paper that the ears cannot be in any way injured in transportation. The samples may then be sent by express to the Connecticut Agricultural Experiment Station, New Haven. In all cases the shipper's name should be enclosed in or marked on the package. If several varieties are sent together, each variety should be separately labeled with its name. The Station will pay the express charges.

At the time of forwarding the samples, fill out and return the following blank for each variety.

1. Name most commonly used and all other names which are sometimes applied.
2. How long raised by you or in your town.
3. Where the seed was first got by you.
4. Whether it has changed its habit of growth, and how.
5. Number of rows to ear, ; of ears to stalk.
6. Time of ripening.
7. Average and maximum height of stalks.
8. Average yield of shelled corn and of stalks or stover, under ordinary conditions.
9. Yield under very favorable conditions. State year and specify the conditions.
10. Planted in hill or drill. Number of stalks in hill. Distance between hills and rows, or between plants and rows in drill.
11. How manured and cultivated.
12. Any other data regarding the sample which the sender thinks important.

The Station will receive and store the samples, will keep with each the sender's name and address, and all data regarding the sample, will make such chemical examinations as may seem desirable, and will endeavor to have all the samples properly exhibited at the Columbian Exposition as well as *permanently preserved in the Station Museum.*

In order that the sending of many duplicate samples may be avoided, it is asked that those having corn suitable for the exhibit will *notify the Station at once, naming the varieties* which they are prepared to furnish. The Station will then write in reply, advising whether to send or stating that the kind is already sufficiently represented among the samples received or promised.

S. W. JOHNSON, *Director.*

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